3.2003
(38)

aerospace technologies review

AIR FLEET

RusAF's Tu-95MS & Tu-160 bombers over Indian Ocean

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Sukhoi/KnAAPO Su-27SK fighter upgrade

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Ansat undergoing sertification tests

YAK-130: THE FIRST PRODUCTION AIRCRAFT ROLLED-OUT!

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CONTENTS

AEROSPACE NEWS FROM RUSSIA & CIS

Military aviation 4

Civil aviation 5
Flight safety 6
Industry 7

Contracts 10
Cosmonautics 12

HOT TOPIC

Heading for Indian Ocean 14

Central Command Post as key element of Russia's Air Defence 16

COMBAT AIRCRAFT

Su-27SK fighter upgrade: old-timer's new capabilities 18

The first production Yak-130 rolled-out .20

ROTORCRAFT

Ansat certification 22

WEAPONS

Computer-aided firing simulators for training armour and aircraft gunners ..26

INDUSTRY

Mikhail Pogosyan: "We are offering high-quality, attractively priced product" 30
We are capable of fulfilling any order .34

ENGINES

Valery Lesunov: "One has to secure his market niche" 36

Heart of fighter 40

Key engine of Russian aviation 42
At the forefront of progress 44
Quality and reliability.
New developments continuing the old traditions 46

AVIONICS

Launching modern onboard computers into series production 48

Simulators lead to flight safety 50

AIR SHOWS

High technologies - 2003 54

COSMONAUTICS

TsSKB-Progress Space-Rocket Center 58

HISTORY

The first all-weather generation. MiG-21PF fighter snd its derivatives ..60

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The Paris Air Show really does matter for the aerospace world community. It is almost as simple as that: if you mean something in aerospace, in mid-June you pack you bags and leave for Paris. In the old Soviet days for many Russians working in aerospace and defence industry the Paris Air Show presented even a more important and unique opportunity to travel abroad and see the western world: otherwise they were not allowed to leave the country they lived in, the Soviet Union. The security guys feared that knowledgeable secret-bearers (a term that really existed in special KGB instructions) would sell Soviet secrets to sexy CIA female agents. Or cunning male James Bond-style SIS agents, it doesn't matter, anyway.

This author used to be one of such secret-bearers. Some 18 years ago Paris became the first foreign city I visited, and the French capital stole my heart forever. Having fallen from outside the Iron Curtain directly into Charles de Gaulle airport as a group of Russian first-ever visitors to the West, the first thing we had to do was to fill in disembarkation cards for immigration control. Naturally, the third line of that paper, after your name and family name, was about your sex, i.e. male or female. However, a friend of mine, an aerospace engineer with no knowledge of either French or English, but fully prepared by security brief back in Moscow was scared by this question. He asked me, almost in despair: "Why are they asking about sex already? We haven't passed through the passport control yet. And should I answer "Yes" or "No"?"

Since then the number of Russians coming to the Paris Air Show has raised, most of them are no longer scared by the question about their sex, but what is more important, the purposes of them coming to Paris have changed significantly. Now most of the Russians here, as well as Ukrainians and other former Soviet nationals, come to Paris not to gather information on western technology, but to do business.

Many joint Russian-Western projects are successfully going on, and one can see evidences of this throughout the pavilions of the Paris Air Show. Areas of international co-operation with the involvement of the Russian industry extend from commercial aviation to space exploration and from joint research even to military programs, definitely something nobody could dream of twenty years ago.

Just to name a few: the European Space Agency Mars Express probe is traveling to Mars after its launch on 2 June by the Russian space booster Soyuz-Fregat from Baikonur site in Kazakhstan, while plans are under discussion of preparations to launch the Soyuz boosters from the ESA Kourou site in the French Guiana. The RSK MiG-AT advanced trainer is flying powered by SNECMA Larzac jet engines, and SNECMA and Boeing act as the key risk-sharing partners in the announced development of Sukhoi Russian Regional Jet (RRJ) aircraft. In mid-summer the Mil-Eurocopter Mi-38 helicopter is planned to perform its maiden flight. The Moscow-based Hamilton Standard-Nauka joint venture announced on 3 June the first delivery of a heat exchanger for the Airbus A380 air conditioning system. And on the same day, 3 June, Airbus and KASKOL Group of Russia announced the opening of the Airbus Russian Engineering Centre in Moscow, the first Airbus design team to be located outside the member countries of Airbus. It is worthwhile to recall, though, that the Boeing engineering centre in Moscow employing over 300 engineers has been operational for several years now. Verkhnyaya Salda Metallurgy Industrial Enterprise has been delivering substantial share of titanium both to Boeing and Airbus, and both major airliner manufacturers are considering orders of aluminum from Russia.

This means that globalization and integration trends of the aerospace industry are applicable to Russia as well as to the rest of the world. And frankly saying, it is the only way of survival for Russia's aerospace industry.

By the way, as far as I remember, that friend of mine answered "Yes" to that question in the disembarkation card even 18 years ago…

Alexander Velovich

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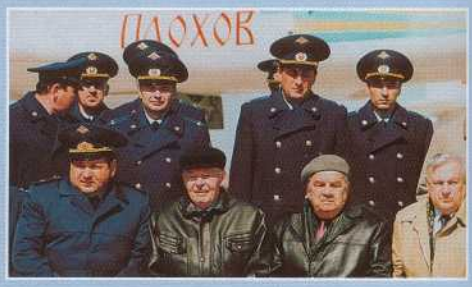
Military aviation

Another Tu-160 got a personal name

On 17 April 2003 an official ceremony was held at the Engels airbase, the home base of the Tu-160 long-range strategic bomber regiment. Another strategic bomber, the tenth to be precise, got a personal name. It was named after Aleksey Plokhov. This is one of the rare occasions when an aircraft is named after a living hero. 82-year old Aleksey Plokhov himself, who had been invited to the ceremony, flew in from Moscow with an escort of the Long-Range Aviation Headquarters officers. It must have felt like a real celebration to him, as the ceremony was scheduled for his birthday.

Aleksey Plokhov entered war on a TB-3 heavy bomber. He carried out 307 combat sorties during WWII and was shot down a couple of times. He also used to fly the SB, TB-3, Li-2, and Il-4, while after the war he flew the Tu-4 and Tu-22. In 1960-63 he was commander of the 106th Heavy Bomber Air Division. In February 1963 he was promoted to Air Force Major General. He occupied the post of Deputy Commander of Long-Range Aviation when he retired. In 1968 he merited the honour of being awarded the highest Air Force decoration - the USSR Distinguished Military Pilot badge. He was also decorated with most existing awards, including the title of the Hero of the Soviet Union.



Russian Air Force to receive new aircraft

The Russian Air Force is to be fielded with both upgraded and new aircraft in 2003. This fact was mentioned by Colonel General Vladimir Mikhaylov, the Russian Air Force Commander, when he addressed officers of the Russian Air Force Pilots' Combat Training and Conversion Centre, based in Lipetsk, on 25 April. General Mikhaylov stressed that new aircraft were being developed for all Air Force combat arms, including long-range aviation, military transport aviation, and tactical aviation. The Air Force is to get Yak-130 combat trainers in the near future, while the Lipetsk Centre will soon be fielded with the new Su-27IB fighter-bomber.

Russian aircraft group to be deployed in Kirghizia

Deployment of an airbase at the Kant airfield in Kirghizia (15km from Bishkek) is slated for July 2003. The group of Russian aircraft, deployed in Kirghizia, will support Collective Rapid-Deployment Forces of the Collective Security Treaty member-states. The decision to transfer a group of Russian aircraft to Kant was taken by heads of Collective Security Treaty nations, including Armenia, Belarus, Kazakhstan, Kirghizia, Russia, and Tajikistan.

The Russian Air Force plans to deploy the following aircraft at the Kant airfield: five Su-27 fighters, five Su-25 attack aircraft, two Il-76 and two An-12 military transports, and an An-30 reconnaissance aircraft, as well as Mi-8 helicopters. Kirghizia will allocate L-39 training aircraft and a helicopter search and rescue team. The total number of the airbase personnel will exceed 1,500 people.

Kirghizia hosts another foreign military airbase, namely the Gansi airbase, deployed at the Manas airport. Kirghizia attaches much importance to providing its airfields to anti-terrorism coalition forces. Bishkek believes that their assistance steps up national security and prevents armed Islamic guerrillas from attacking its territory, as well as provides the national budget with considerable additional financial assets.

The following sources were used while preparing Aerospace news from Russia & CIS: ITAR-TASS, Interfax and RIA-Novosti news agencies reports, as well as Internet sites: www.gazeta.ru, www.rian.ru, www.strana.ru, www.regions.ru, www.rbc.ru, www.newsru.com, www.finiz.ru, www.gzt.ru, www.1tv.ru, www.cosmoworld.ru.

Ruslan joins NATO

The decision of the NATO Strategic Airlift working group on selecting aircraft to be fielded with NATO member-states by 2004 may be taken as early as mid-June. The Russo-Ukrainian An-124-100 Ruslan heavy transport is the primary option in the bid. NATO wants a total of six aircraft, which are planned to be leased from Russian and Ukrainian air carriers, as well as the Russian Air Force.

According to official sources, NATO urgently needs the aircraft in question to support its anti-terrorism, peacekeeping, and humanitarian operations, but western military experts believe that such a sudden interest in the Ukrainian heavy transports must have been caused by the fact that the alliance does not want to wait for the A400M transport, promised by Airbus Military.

The A400M may be launched into series production no sooner than 2008, thus, at the moment NATO is looking into a feasibility of leasing US C-17s, as well as Ukrainian and Russian An-124-100s. It will cost $3 billion to lease a dozen of C-17s for a decade, while six An-124-100s may be leased for $1 billion.

NATO authorities justify their choice by the fact that in 2002 NATO cooperated with the Volga-Dnepr air carrier, the largest operator of An-124-100s, in the sphere of military airlift operations. Last year the air carrier earned about $100 million by carrying out flights in the interests of European NATO member-states (Ruslans carried out 260 flights only to Afghanistan).

At present An-124-100s are operated by one Ukrainian air carrier, namely Avialinii Antonova, and two Russian air carriers - Polet and Volga-Dnepr. The Russian Air Force operates 26 An-124 aircraft, while in early 2003 the Atlant-Soyuz air carrier planned to procure aircraft of this type from the Russian Air Force, while the Polet air carrier has already received from the Air Force and converted four An-124s.

Ukraine and NATO have been cooperating since 1997 under the special partnership charter, signed by both parties concerned. Ukraine has undertaken to fill the alliance's needs in strategic airlift in the near future, but it cannot completely satisfy NATO's needs in six Ruslan aircraft.

The Ulyanovsk-based Aviastar plant is completing a modified An-124-100M aircraft for the Volga-Dnepr air carrier. The new aircraft is fitted with new avionics and meets all international standards. Besides, the lifting capacity of the An-124-100M has been increased from 120t to 150t due to the reinforced airframe. Another standard An-124-100 is being manufactured in Kiev.

At the present time the Volga-Dnepr air carrier continues negotiations with the UK on certifying its An-124-100s there. The British certificate may be obtained as early as late 2003.

Civil aviation

Il-114 starts regular flights from St. Petersburg

The Il-114 regional passenger airliner started regular services from St. Petersburg in early May. The Il-114 is operated by the St. Petersburg-based Vyborg air carrier. At the present time the company in question leases two aircraft of this type. They are expected to be joined by another aircraft in the near future.

Russian airliners to become terrorist-proof

The Russian government has introduced a number of amendments and additions to the Provision on the federal protection system of civil aviation from illegal actions.

This holds true for passenger aircraft with a maximum takeoff weight of over 45.5t, or a seating capacity of over 60 passengers.

From now on aircraft like that will be fitted with automatic bullet-proof doors, closed by the pilot. In addition to that, airliners are supposed to be equipped with contemporary security systems, such as video cameras and intercom between the crew and cabin attendants. They will also mount special containers for disposing of explosives, found onboard. Design of new airliners will also sustain certain modifications; for instance, aircraft will be fitted with covert passageways and crawlways, designed for special forces to covertly get into the cabin.

And last but not least, aircraft will be fitted with antitheft alarms, which are supposed to prevent anyone from illegally opening aircraft doors and maintenance hatches, starting the engine, taxiing, and taking off.

Flight Safety

Mi-26 crash in Russia's Far East

On 3 May 2003 a Mi-26 helicopter of the Russian Emergency Ministry crashed while putting out forest fire north-east of the village of Novokruchinsky in Russia's Far East Chita region.

As many as 12 people were onboard the aircraft. The accident claimed lives of four reporters, among them a Rossiya Channel camera crew and correspondents of Yezhenedelny Journal weekly.

According to data available at the moment, the crash was caused by the sling water bucket cable getting caught on the tail rotor of the helicopter. Russian Emergency Minister Sergei Shoigu said that the tail rotor and the cable coiled round it were found at the crash site, which proves the preliminary version.

The black boxes of the aircraft found and deciphered, the Emergency Ministry will not make public the cause of the accident before the end of the investigation.

Despite rampant forest fires in the region the Emergency Minister prohibited employment of aircraft fitted with fire-fighting water buckets right after the accident, the ban unlikely to be suspended before the cause of the crash is known.

Sling water buckets have been used for fighting forest fires for a decade now. They were first employed by officers of the Krasnoyarsk Regional Forest Protection Air Base. No crash has occurred due to employment of buckets before.

A fleet of 100 Mi-26T helicopters is now employed by airlines on four continents. The aircraft with 15 cu. m VSU-15 buckets are efficiently employed on fire-fighting missions. A pilot observer is included in the crew once the helicopter is fitted with a sling bucket of the type. Employment of the helicopter ensures quick transportation of water to the fire site and high precision of discharge, which enhances efficiency of water employment and decreases time necessary for extinguishing fires.

The Air Group of the Russian Emergency Ministry operating three Mi-26T rotary-wing aircraft has been fighting fires in Greece for four successive years. The tragedy in the Chita region is unlikely to damage the solid reputation of the aircraft that is still justly considered to be unparalleled both in weight-lifting capabilities and operational reliability.

In-flight incident claims lives of Il-76 passengers

Something strange happened to a Ukrainian Il-76 cargo aircraft in airspace of the Democratic Republic of Congo, former Zaire, on 8 May 2003. The airlifter of the UATK Ukrainian Air Transportation Company was rented by the Congolese Defence Ministry for charter flights between Kinshasa and the country's second largest city Lubumbashi.

According to first news reports, passengers of the aircraft, their number ranging from seven to 250 people, were sucked out of the aircraft when the ramp hatch opened at an altitude of 2,000m. The crew of the plane managed to turn the aircraft round and fly back towards the capital. UATK and Ukraine's Defence Ministry claim that no passengers were killed in the accident. The tragedy occurred 40 minutes after the plane took off. At an altitude of 7,000m the commander of the aircraft detected depressurisation in the cargo hold, steered the aircraft down and turned it round to the Kinshasa airport. A team of Ukraviatrans experts have been dispatched to Congo to investigate into the crash.

The government of the Democratic Republic of Congo confirmed death of seven passengers, yet later it was said that the number of casualties might rise to 170 people. A special commission was set up to identify the reason of the event and the number of the passengers killed. Representatives of the Kinshasa airport said that some 129 people died; the survivors, for their part, say that the number of casualties was greater, for the aircraft was overloaded.

According to data provided by the Congolese government, the aircraft was carrying policemen and members of their families flying to Lubumbashi to participate in the festivities on the occasion of the Revolution Day. The passengers got on board the aircraft through the rear ramp, a practise not at all unusual in Africa. Some experts believe the tragedy occurred due to malfunction of the ramp door or the pilots' failure to properly fasten the hatch. Witnesses maintain the door opened following three attempts to shut it in mid-flight. A similar accident happened in 1974 on board an aircraft en route from Istanbul to Paris, as many as 346 people killed as a result. The investigation into the tragedy showed that the Turkish technician turned a knob the wrong direction due to his failure to understand instructions written in English.

Official representatives of the Democratic Republic of Congo said that Il-76 aircraft operated in the country for quite some time and boasted a superb record. The Congolese Minister of Information added that the planes were noted for their operational reliability, especially as far as air-lifting cargoes of several thousand tonnes is concerned. The minister referred to the tragedy as a misfortune that might have occurred anywhere in the world.

Industry

MiG-AT to be certified

The MiG-AT training aircraft, powered by French Larzac engines, is to be certified in June 2003 by the outset of the Le Bourget air show. The MiG-AT project is developed jointly by RAC MiG and French Snecma and Thales.

NRB earmarks grants to VASO

The National Reserve Bank has allocated a lax credit of RR390 million (about $12.6 million) to the Voronezh Aircraft Production Association. This fiscal shot in the arm will allow the enterprise to repay all of its debts and start operating under normal conditions.

At the present time VASO is manufacturing six Il-96-300 passenger airliners for the Aeroflot air carrier and two Il-96-400T transports for the Atlant-Soyuz air carrier. The plant is financed by the Ilyushin Finance leasing company, whose major shareholder is NRB.

Establishment of the new Russian aircraft association, namely the Ilyushin Corporation, is slated for autumn 2003. This spring VASO shareholders voted for joining the new corporation.

In addition to producing Il-96 airliners and re-engining Il-76MDs VASO plans on manufacturing Il-76MF and Il-112 aircraft.

Upgraded MiG-29SMT for Yemen

The Russian MiG corporation has delivered the fourth upgraded MiG-29SMT fighter prototype. The fighter is fitted with the complete equipment suite, stipulated for in the contract with Yemen. The fighter in question is considered to be the pattern aircraft. Following the tests a report whether the aircraft may be exported is expected to be obtained in the next two months.

The avionics suite comprises the Zhuk-M radar, cockpit instrumentation, developed by the Ramenskoye Instrument Design Bureau, and the French Sagem navigation system. The fighter is also equipped with the in-flight refuelling system.

All the systems mentioned above have already been tested on other MiG-29 prototypes, while the MiG-29SMT is designed for the final test of new equipment.

National Reserve Bank proposes setting up corporation

The National Reserve Bank (NRB) has proposed that a national Russian corporation should be established by merging the Voronezh Aircraft Production Association (VASO) and Ulyanovsk-based Aviastar. The project is currently at the initial preparation stage, but the Russian Antimonopoly and Business Support Ministry has already given thumbs up to the NRB initiative.

In December 2002 the Ilyushin Finance Company (NRB holds 46 per cent of its shares), which is a participant in the governmental programme for leasing civil aircraft, received 56 per cent of VASO's shares in trust stocks. Last year NRB also submitted a request to the Russian government, aimed at getting government's shares in Aviastar in trust assets.

Il-76MF to be launched into production

On 24 April 2003 the Tashkent Aircraft Production Corporation (TAPC) issued a Report on completing the first stage of joint official tests of the Il-76MF military transport. The results of the tests, which had been under way for almost six years, lead to a preliminary decision to launch the aircraft into production.

The Il-76MF is supposed to be produced by VASO and TAPC. Viktor Livanov, Director General of the Ilyushin Aviation Complex, stated that "in any case the aircraft would be produced by the Ilyushin Corporation".

The Il-76MF made its maiden flight in August 1995, while at the moment the first prototype has carried out almost 1,500 flights. According to experts, the Russian Air Force's needs in Il-76MFs are assessed at 100 aircraft.

The Il-76MF differs from the Il-76MD in having new PS-90A power plant and a 6.6-m longer fuselage, which resulted in a 1.5-fold larger cargo hold. The aircraft's lifting capacity has been increased 1.3- to 1.5-fold, while its fuel-consumption efficiency has been improved by 15 per cent. The aircraft also meets ICAO requirements as far as noise and emission levels are concerned.

Flying laboratory based on Il-103

The Ilyushin Aviation Complex and the Russkaya Avionika Company propose that a flying laboratory for testing and fine-tuning avionics, in particular, display systems, should be based on the Il-103 aircraft. In late May – early June 2003 the aircraft is expected to be fitted with the liquid crystal navigation display and a foreign inertial system. The first stage of flight tests will see refinement of operational algorithms and software. The aircraft will be displayed at the MAKS 2003 air show in Zhukovsky near Moscow.

Later on the Il-103LL is supposed to be used for testing future display systems to be fitted on various types of aircraft, including the Il-76MF, while in the future it will also become the basis for developing a "flying desk" for training pilots and navigators. With this end in view workstations will be fitted with piloting and navigation LCDs.

New Air One makes its maiden flight

On 21 April 2003 Viktor Galkin, a test pilot of the Voronezh Aircraft Production Association, took the new presidential aircraft for its maiden flight. Following several flights in Voronezh the Il-96-300PU(M) was ferry flown to Moscow for final refinement and installation of special equipment. The tests are to be held for a month, while by June the aircraft is expected to be handed over to the Rossiya air carrier. As soon as the aircraft is handed over to the air carrier, the current Air One will become a backup aircraft instead of the present Il-62.

At present President Putin uses the Il-96-300PU aircraft, built for President Eltsin in 1996. The cargo deck has been replaced by offices. The aircraft quarters two bedrooms, bathrooms, a conference hall, a recreation room, and a medical station.

Although the presidential Ilyushin is yet to expire its service life, in early 2002 the federal budget earmarked $36 million to VASO for manufacturing the new Il-96-300PU(M) aircraft. The new aircraft differs from its predecessor in interior design, power plant, and avionics. The Il-96-300PU(M) has completely been manufactured in Russia, while the interior design was ordered by presidential staff as far back as 2001. All things inside the cabin, starting from silk engravings, showing historical scenes, produced by the Pavlovo-Posad plant, to furniture, manufactured by a joint Russo-Belgian enterprise, are national.

The Il-96-300PU(M) meets all contemporary and future requirements, facing international civil aviation, and is capable of carrying out non-stop flights in adverse weather conditions almost to all large international airports.

SA-20P progressing through flight tests

The SA-20P multi-purpose amphibious aircraft has completed the first stage of factory flight tests. The tests have proved the design solutions introduced to be correct.

In order to realise the SA-20P project KnAAPO established a special design bureau, which secured permission of the Taganrog Aviation Scientific-Technical Complex to use the already developed and tested fuselage of the Be-103 amphibious aircraft, for developing the SA-20P. At the present time KnAAPO has completely mastered the SA-20P production technology and is fitted with necessary equipment.

Unlike the Be-103 twin-engine amphibious aircraft, the SA-20P flying boat is powered by one national M-14X engine, mounted on a pylon over the fuselage, which prevents it from being splashed at takeoff and landing.

The SA-20P's maximum takeoff weight totals 2,270kg, the payload weight equals 634kg, while its maximum altitude is 3,000m. The amphibious aircraft is capable of flying to a range of 1,030km, when provided with a maximum fuel load and a half-hour emergency fuel load. The aircraft is designed to carry five passengers.

KAPO to build Tu-214 for Russian MoD

The Russian Ministry of Defence is expected to place an order with the Kazan Aircraft Production Association (KAPO) for manufacturing special purpose aircraft, based on Tu-214 passenger aircraft. The Russian Air Force Commander has already signed a request for proposal for developing a 'Salon' version of the Tu-214 for the Russian defence minister. In addition to that the Russian MoD has ordered another two modified aircraft, based on the Tu-214 passenger airliner, to be delivered in 2007.

In 2003 KAPO plans to deliver one Tu-214 to the Dalavia air carrier, and another one to the Rossiya State Transportation Company (GTK). In March 2003 the total flying time of two existing Tu-214s, operated by the Dalavia air carrier, exceeded 450 hours.

The first Tu-214 prototype is being prepared for new tests at KAPO to be held in late May. The range of the aircraft is expected to be increased up to 9,200km.

In addition to domestic deliveries the enterprise is currently conducting negotiations with a number of foreign states on exporting the Tu-214 via Rosoboroneksport. For instance, Libya may need six Tu-214s, including one 'Salon' version.

Winner to be named in short- and medium-haul airliner bid

The tender commission has discussed projects, submitted to the bid for a 130-170-seat short- and medium-haul passenger airliner. Preferences were given to the joint project, based on the Yak-242 aircraft, introduced by the Ilyushin Aviation Complex and the Yakovlev Design Bureau.

The Irkut Scientific Industrial Association (former IAIA) also participated in the contest with a project, based on the Russo-Indian Il-214 aircraft.

The new short- and medium-haul airliner is to be superior to its foreign counterparts (Airbus A320, Boeing 737, and Boeing 717) with respect to the cost-efficiency ratio. It is also to have a specific fuel consumption of not more than 17 g/passenger-km, as well as a comfortable passenger cabin. The aircraft is expected to be fitted with the high-speed wing, designed by TsAGI experts, which will enable the aircraft to increase its cruise speed. Composite materials are to be widely used in the new airliner.

Power plant options for the new aircraft comprise several types of engines, including new developments of the Perm Engine Company.

The official winner in the bid is to be named on 25-27 May.

Ilyushin celebrates two anniversaries

The Ilyushin Aviation Complex celebrated its 70th anniversary on 17 April 2003.

The anniversary marked a number of cornerstone events. First and foremost, they included establishment of the first Russian corporation, merging the design bureau and the Voronezh Aircraft Production Association to become a single aircraft company.

In addition to that on the eve of its anniversary the Ilyushin Aviation Complex won the bid for the best light military transport for the Russian Air Force. Under the decision of the Russian government, VASO is expected to undertake preparations for launching the Il-112 into production in the near future.

On 18 April it has been 25 years since the Il-76 transport made its first appearance on international airlines. The Il-76, sporting the Aeroflot banner, carried out its first international flight from Moscow to Sophia in April 1978. After that it started flying to Warsaw, Plovdiv, Varna, and Burgas. In December 1978 it began carrying out flights along the Luxemburg-Moscow-Vladivostok route. In February 1986 it conducted a flight from Moscow to Antarctica. The Il-76 crew landed its aircraft on an ice airfield of the Mirniy station for the first time in the world's history.

SM-146 selected for RRJ

The SM-146 power plant has been selected to be fitted on the Russian Regional Jet (RRJ) family aircraft. The trilateral memorandum of intent was signed by Sukhoi, Snecma Moteurs, and Saturn in Paris on 29 April.

The SM-146 is one of Russia's first promising international projects in the sphere of aircraft engine-building.

An-140 series production

The Kharkov State Aircraft Manufacturing Company intends to manufacture 33 An-140 aircraft by 2005. The company plans to produce six aircraft in 2003, 12 aircraft in 2004, and 15 aircraft in 2005. In addition to that another 22 aircraft of this type will have been built by the HESA plant, based in Isfahan, Iran, by 2005. The Russian Samara-based Aviakor plant plans to manufacture 14 An-140s within the same period of time (two in 2003, four in 2004, and eight in 2005).

Contracts

Russian fighters to protect Malaysian skies

The meeting between the Russian Defence Minister and his Malaysian counterpart held last month in Kuala Lumpur proved stable development of the cooperation between the two countries. As a result, Russia's new fighters will soon begin their service with the Malaysian Air Force.

On 19 May 2003 Russia and Malaysia initialled a contract for deliveries of 18 Russian-made Su-30MKM fighters, the total cost of the batch mounting up to $900 million. Russia's Defence Minister Sergei Ivanov said that the agreement in question provides for after-sales maintenance and upgrade of the aircraft. The assets are to be delivered to Malaysia within five years starting from the year 2006.

The contract for new Russian fighters to be finalized in the next few months will most likely be signed during President Putin's visit to Malaysia this summer. Malaysian Defence Minister Najib Tun Razak said that the Russian Su-30MKM fighters were procured as part of the national Air Force upgrade program.

A contract of such scope is most important for Russia, as well. Noted for its stable economic development, Malaysia is a leading ASEAN nation. As many as 18 MiG-29 fighters of Russian make already fielded with the national Air Force, Sukhoi planes will soon enter the inventory of the Malaysian armed forces, too. The territory of the country has extended borders, which makes Su-30MKM's capability to fly 3,000km without refill a valuable feature indeed. A special mention should be made of the aircraft's winning the tender for multirole fighters to be adopted by the Malaysian Air Force, US F/A-18E/F Super Hornet participating in the competition as the principal rival of the Russian aircraft. However, aircraft of American produce can be procured along with Su-30MKM fighters, the way it was in the mid-90s when Malaysia bought a batch of 18 Russian MiG fighters and eight US F-18D aircraft.

The Su-30MKM super-agility two-seater was derived from the Su-30MKI fighter now being exported to India by the Irkut Corporation. Just as the baseline version, the new aircraft is powered by the AL-31FP TVC engine. The avionics and armament suite will most likely be similar to those of the Su-30MKI. The new fighter differs from its predecessor in having Russian and, perhaps, Malaysian systems instead of Israel- and India-made ones employed on the Su-30MKI aircraft.

Su-27 for Indonesian Air Force

On 24 April 2003 Indonesia, an ASEAN nation, signed a contract with Russia for delivering four Sukhoi-type fighters and two combat helicopters, the total cost of the agreement rising to $192,9 million. Under the contract Russia is to supply to Indonesia two upgraded Su-27SK single-seat fighters, two Su-30MK multirole two-seaters and two Mi-35 combat helicopters, along with accessories of some 30 types. As much as $15 million of the contract's worth will be paid in goods.

Deliveries of the aircraft will start as early as September this year, spare parts to be supplied from May 2003 till October 2004. All the Sukhoi fighters are to be shipped to Indonesia by autumn 2003; the aircraft will be built by KnAAPO.

Military and technical cooperation between Russia and Indonesia boasts a history of many years. The Soviet Union supplied arms to Indonesia once the country declared its independence in 1945. In the early 1960s, for instance, the USSR delivered to the country Tu-16KS aircraft carrying KS-1 cruise missiles, as well as MiG-19S fighters. However, change of the national government in 1965 led the two countries to break off their relations and accounted for Indonesia's shift towards American weapons. As a result, the inventory of the Indonesian Air Force now includes F-16 and F-5 fighters, their operational range insufficient for reliable protection of the country's borders.

In the mid-1990s Indonesia turned towards Russian weapons again. In 1997 the countries signed a protocol stating Indonesia's willingness to procure eight Mi-17V helicopters and 12 Su-30KI single-seat fighters derived from Su-27SKs. The assets were never delivered to the country due to the economic crisis in 1997, so implementation of the protocol was put off till indefinite time.

Indonesia reiterated its interest towards weapons of Russian produce two years later, following the US decision to impose arms embargo on the nation due to terror in East Timor. A contract for delivering four Mi-17 helicopters of the Kazan helicopter plant was signed in 2000; supply of an additional batch of two Mi-17 and eight Mi-2 aircraft was agreed upon in May 2001. The total cost of the contract was assessed at $20 million. Negotiations on procurement of Su-30-type fighters were resumed in 2001, too.

On 22 April Indonesian President Megawati Sukarnoputri visited the Sukhoi test base in the town of Zhukovsky, Moscow region; the itinerary provided for a display of Su-30MK and Su-27SK aircraft. Sukhoi Director General Mikhail Pogosyan expressed deep satisfaction with the results of the talks. Sukarnoputri, for her part, said she was astounded by the capabilities of the Russian fighters.

Upgrade of Poland's MiG-29s

A meeting between Russian Defence Minister Sergei Ivanov and his Polish counterpart Jerzy Szmajdzinski was held in late April this year. In the course of the negotiations Ivanov expressed his concern over the US plans to redeploy troops now stationed in Germany to Poland. Nevertheless, military and technical cooperation between the two countries is still very much underway.

On 22 April 2003 the Defence Ministers signed an agreement on exporting Russian weapons, military hardware, spare parts and maintenance services to Poland. The Polish Air Force operates 22 MiG-29 fighters, their number likely to increase after the country gets an additional batch of aircraft of the type from Germany. Most of the Polish MiG-29s are in bad need of repair, which, too, was one of the problems discussed at the ministers' meeting.

In April, in the wake of an eight-year tender, Poland decided to procure F-16 fighters, yet the first US-made aircraft will not enter the inventory of the Polish Air Force before 2006. Apart from that, it will take another two years to turn the first Polish F-16 squadron into a combat-capable unit. Before that the task of protecting the nation's airspace will be performed by MiG-29s.

Modernisation of Bulgaria's helicopters

Obsolescence of the aircraft fleet in service with the Bulgarian Air Force is one of the most serious problems related to the combat readiness of the national armed forces. This is especially true for Russian-made rotary-wing aircraft, specifically Mi-24 and Mi-17 helicopters adopted by the Bulgarian Air Force as far back as 1983. Service lives of the assets will have to be extended after they expire in late 2003, the problem unlikely to be solved without participation of the helicopter's developers, experts of the Moscow Mil Helicopter Plant. Overhaul and upgrade of the aircraft will cost the Bulgarian Defence Ministry some $15-30 million. Among the participants in the tender are Eurocopter, BAe Systems, Elbit Systems, and IAI. The Russian side will probably operate in collaboration with foreign subcontractors, for the aircraft will be upgraded in compliance with NATO standards.

Il-103s to be delivered to South Korea

Deliveries of Il-103 light multi-purpose aircraft to South Korea will most likely begin in September 2003. The aircraft will be shipped to the country in batches of several planes, deliveries to be completed in 2004.

The contract for 23 Il-103 aircraft was signed on 16 May 2002 by the RAC MiG corporation and the Defence Ministry of South Korea, its cost totalling $9 million. Half of the sum will be written off Russia's national debt.

Training course for South Korean experts operating and servicing Il-103 aircraft will start this summer. Under the contract, maintenance and repairs of the Russian planes will be performed by the South Korean LG International Corporation.

Ukrainian air carriers to buy 10 An-140s

In 2003 Ukrainian carriers are going to acquire from the Ukrtranslizing leasing company ten new An-140 turboprop regional aircraft.

An-140s have been mass-produced by the Kharkov State Aircraft Manufacturing Company since 1999. This year the plant is to put into operation six new planes of the type. An-140s are now employed by two Ukrainian air carriers, Odessa Airlines and Aeromost-Kharkov.

Ka-31s for India

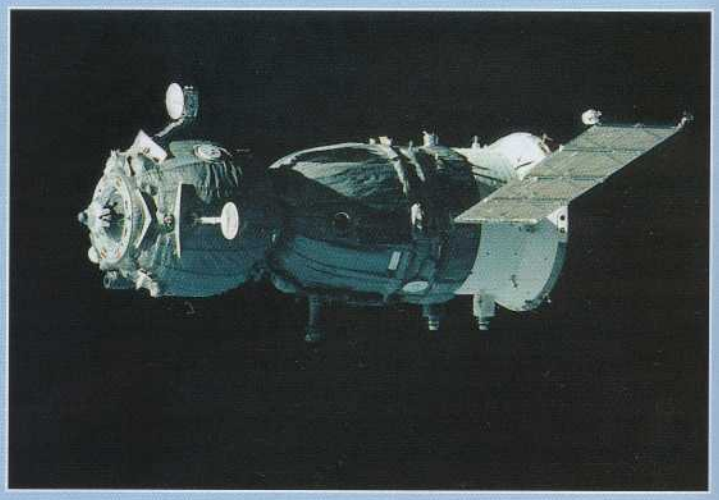
In mid-April 2003 another batch of two Ka-31 radar picket helicopters was delivered to India by the Kamov Company under the contracts signed earlier by Russia and India. In 1999 India placed an order for four Ka-31 helicopters, the cost of the contract mounting up to some $92 million. The second contract worth $108 million was signed by Rosoboronexport and India in February 2001; the agreement provides for delivering another five aircraft of the type. The first two Ka-31 helicopters were handed over to the Indian side in 2002, the remaining batch of five aircraft to be supplied before the end of the next year.

Ka-31 helicopters will be employed for over-the-horizon detection of surface targets and supplying corresponding data to ships mounting strike missile assets. The E-801M Oko early warning radar system makes up the basis of the helicopter's avionics. The radar features a large rotating phased array with an area of 6 sq. m. Operating at an altitude of 3,000km, the Ka-31 is capable of detecting up to 200 fighter-type targets and simultaneously tracking 40 of these at ranges from 110 km to 115 km.

All the Ka-31 helicopters supplied to India boast upgraded cockpits and are fitted with the Kabris global navigation and landing systems developed by the Kronstadt company.

Cosmonautics

Soyuz TMA-1 descent



Another crew returned to the Earth from the International Space Station (ISS) on 4 May 2003. That day the Soyuz TMA-1 spacecraft undocked from the International Space Station, the astronauts started the retroengine, the spacecraft undocked and started descending to the Earth. It landed outside the town of Turgay, Kazakhstan. The spacecraft descended on a parachute and landed in compliance with the standard landing system operation procedure.

The Soyuz spacecraft are designed to sustain the following three landing modes: the automatic mode, the manual mode, and the ballistic trajectory mode. When the spacecraft entered atmosphere, the landing control system ordered the Soyuz to follow a ballistic trajectory. The spacecraft deviated from the trajectory calculated and landed 460km off the landing zone specified. That is why it took longer than usual to find the spacecraft: a pair of Mi-8 helicopters arrived at the landing zone four hours after the astronauts had touched down. The crew and the spacecraft were evacuated from the landing zone under the usual procedure. Six hours later the astronauts arrived at the Chkalovsky airfield.

By and large, the ISS-6 crew, comprising NASA astronauts K. Bauersocks (commander) and D. Pettit (flight engineer), as well as Russian cosmonaut N. Budarin (flight engineer, test cosmonaut of the Energiya spacecraft), had dealt with all surprises during the descent quite professionally, while the physical condition of astronauts was satisfactory.

It is premature to come to any conclusions with respect to the spacecraft's following a ballistic trajectory, until a special commission delivers its report. However, some experts believe that the error might have been made by the crew, as the astronauts had been preparing to fly a Space Shuttle. N. Budarin was the only one on the crew to have flown a Soyuz, while commander K. Bauersocks had never landed a Soyuz before and had to master skills for flying Russian spacecraft directly on orbit. On 6 March the Russo-American crew appeared at a news conference. All astronauts looked cheerful and unanimously rejected any speculations that the crew might have caused the descent of the spacecraft in a non-standard mode. When the Flight Control Centre transmitted a control signal for switching the spacecraft into a manual landing mode, the onboard automatic equipment suddenly ordered it to follow a ballistic trajectory. As a result the crew had to sustain an acceleration of more than 8 G. The communications failure during landing was caused by a break up of a parachute cord, which mounted the transmitter aerial. Right after landing communications were re-established with the help of the auxiliary aerial.

The ISS-6 crew has successfully fulfilled its mission. Soyuz TMA-1, which had been in orbit for 186 days as part of the ISS station, was replaced by the Soyuz TMA-2 spaceship, which delivered to the space station the ISS-7 crew, comprising Russian cosmonaut Yury Malenchenko (commander) and NASA astronaut Edward Lue (flight engineer).

At the present time the 179.6-t space station consists of the Zarya cargo module, the Zvezda service module, the Pirs docking module, the Soyuz TMA-2 spaceship, the Progress M-47 cargo spacecraft (Russian sector), the Unity and the Destiny modules, the Quest lock chamber, and the large multi-unit girder structure, mounting solar batteries (the US sector).

The ISS-7 crew continues the flight programme in the orbit. The current crew will be succeeded by a crew of Soyuz TMA-3 to be launched in autumn 2003.

Any money earmarked for MASS?

The Defence Committee of the State Duma turned to Russian President Vladimir Putin with a request that the government should allocate RR200 million (about $6.7 million) for the multi-purpose air-space system (MASS) project. This fiscal shot in the arm will allow the Molniya Scientific Industrial Association to set up a new network of subcontractors, employ new materials and equipment, i.e. introduce state-of-the-art technologies to the MASS project.

The MASS project was initiated in the late 1970s. The system was to become a huge step forward in developing systems for launching cargo into space: the cost of launching a kilogram of payload into space was expected to be reduced to $1,000-1,500. The conceptual design was adopted in 1989.

The cost of the project is estimated at $2.7 billion, thus, at the present time Russia just cannot do it alone. The situation may be improved by the fact that in spring 2003 Molniya obtained permission to establish independent international relations, which will enable the enterprise to set up closer cooperation with its foreign counterparts.

The MASS project is likely to become a juicy contract for West European states, which do not enjoy any space-launch sites in Europe. The MASS system will allow the participants in the programme to launch various payloads into space almost from the equator, as the An-225 carrier platform may be refuelled in the air.

Another cargo spaceship to be launched to ISS in June

The launch of another Progress-M cargo spaceship to the ISS station is slated for 8 June. The spaceship is to deliver to ISS fuel, service equipment for scientific experiments, food containers and parcels for the crew, and onboard documentation. The total weight of the cargo is expected to equal 2.5t. The spaceship will be launched from the Baikonur Cosmodrome with the help of the Soyuz launch vehicle. This launch will be the 101st one for the Progress family spacecraft and the 11th one to the ISS station. Rosaviakosmos expects to launch the following three spacecraft to ISS within the framework of the international programme: one manned Soyuz spaceship, and two Progress cargo spacecraft.

Launch system for Angara LV built in Plesetsk

The Plesetsk Cosmodrome outside Arkhangelsk started building a launch site for the new Angara family launch vehicles. The cosmodrome is currently restoring its production capabilities, starting construction works, building living quarters for military construction workers, a water intake, and electric power lines.

While construction workers are building special structures, the launch vehicle proper is being designed. At the same time it was decided to bypass development of light and medium Angara family rockets, and start designing directly the heavy Angara-5 launcher.

Another test of the liquid-propellant rocket engine to be mounted on Angara LV

In April 2003 the RD-191 liquid-propellant rocket engine, designed by the Energomash Scientific Industrial Association named after V.P. Glushko for the Angara family LVs, underwent its eighth test. At present Energomash has two power plants like that, which are ready for test-bed firing, slated for May 2003. The new engine is expected to be launched into mass production in two to two and a half years.

The RD-191 liquid-propellant rocket engine, which boasts a thrust of about 200t, features extremely high energy characteristics. It is based on the RD-170 and RD-171 engines with an oxidising gas afterburner. Unlike its four-chamber predecessors, the RD-191 engine is fitted with just one combustion chamber and a new lower-power turbo-driven pump assembly.

Satcom development programme

The Russian Ministry of Communications and Information ordered a number of scientific institutes to work out a new satellite communications and broadcast development programme for 2005-2010. This information was delivered by Leonid Reiman, the Russian Communications and Information Minister, on 12 May. He said that the first similar programme until 2005, adopted by the government in 2000, had allowed four Ekspress satellites to be developed and launched into the geostationary orbit. The satellites in question have been designed by the Krasnoyarsk-based Reshetnev Scientific Industrial Association of Applied Mechanics.

Another five Ekspress spacecraft are currently under production and are expected to be also launched to the orbit by late 2005. The programme also envisions developing new modifications of satellites, which will become operational after 2005. The minister emphasised that the new space programme is a commercial one, though supported by the state.

Upgraded RD-107 liquid-propellant rocket engine completes tests

In late April 2003 the Energomash Scientific Production Association completed another stage of flight tests of the upgraded RD-107 liquid-propellant rocket engine, designed to be mounted on the Soyuz launch vehicles.

The upgraded ignition system of the RD-107 will make it easier to prepare the rocket for a launch and will increase its reliability. The traditional RD-107 ignition system envisioned mounting a stand with a sparkler-type blasting cartridge on a launch system from the side of the nozzle. When the first portion of the oxidiser and fuel was fed into the combustion chamber, the device sparked up and ignited fuel. The new ignition system operates on a self-igniting chemical mixture, which provides stable ignition of such standard fuel components as liquid oxygen and kerosene. The Energiya and Zenit launch vehicle engines have already been fitted with the chemical ignition system. Now, following the tests, it will also be mounted on Soyuz launchers.

The RD-107 and RD-108 engines have been operational for over 40 years, which proves their outstanding reliability. The liquid-state rocket engines in question have undergone several modernisations throughout their service lives. The RD-107 and RD-108 engines, designed by Energomash, are produced by the Samara-based Motorostroitel Industrial Association. These engines are the world's leaders with respect to the number of launches, having launched into space in excess of 1,600 launch vehicles.

Military satellite launched from Baikonur

On 24 April 2003 combat crews of the Russian Space Forces launched the Proton-K launch vehicle, fitted with the DM-2 booster, which mounted the Kosmos-2397 satellite, from the Baikonur Cosmodrome. The launch was carried out in the interests of the Russian Ministry of Defence. The booster launched the satellite to the specified geostationary orbit.

The satellite has established and is maintaining stable telemeter communications. Its operation is supervised by the command and control post of the Space Forces. The satellite has been designed by the Lavochkin Scientific Industrial Association.

HEADING FOR INDIAN OCEAN

Russian Long-Range Bombers over Arabian Sea

Of all the traits of character inherent in strategic aviation pilots their superstition and tolerance of religion are the most conspicuous, and the reason for this is that every flight of a long-range aircraft is a combat mission, where any error might be fatal.

Operating a long way from their homeland, four or eight men confined in a small aircraft cockpit are left for several dozen hours all by themselves, confronting whatever they might encounter at high altitudes, always ready to fight the enemy. Whether they will return home depends on the expertise of the crew and luck.

Under the Air Force training plan, command post exercises, involving the 37th Air Army of the Supreme Air Command and supervised by Air Force Commander Colonel General Vladimir Mikhailov, were held in late May.

Lasting for five days, the event covered interaction of long-range aviation with other services, namely the Navy; as well as mastering navigation, bombing and missile launching skills of flight personnel, manning heavy bomber regiments, comprising live missile launches and bomb strikes, including those of strategic air-to-surface cruise missiles. The exercise in question consisted of two stages, conducted in the Russian airspace (spanning the extreme North and baking-hot South, western boarders and the Russian Far East), as well as strategic ocean areas (the Arctic Ocean and the Pacific).

For the first time in the recent history of Russia and its Air Force strategic bombers took off almost simultaneously from several airfields and headed for various corners of the world to fulfill their combat training missions, including those outside the national airspace. The Air Force Commander was quoted as saying that the Long-Range Aviation had not carried out such large-scale training exercises in the past 12 to 13 years.

The exercises saw participation of the following aircraft: the Tu-160 strategic bombers, justly considered to be the pride of the Russian Air Force, the Tu-95MS bombers (which have been in service with the Russian Air Force for almost half a century), the Tu-22M3 long-range bombers, and Il-78 air tankers. On completing long flights to their respective target areas, the bombers launched air-to-surface missiles and dropped bombs on Russian northern target ranges off the Island of Novaya Zemlya and southern firing grounds near Guryanovo, outside Saratov, and Vladimirovka, outside Astrakhan.

"Combat operations" were especially demanding on the southern theatre of operations. For the first time in the past several decades Russian strategic bombers have covered a range of over 10,000km, flying through airspace of four neighbouring states (Kazakhstan, Turkmenistan, Afghanistan, and Pakistan), and arrived in the open Indian Ocean (the Arabian Sea), where two Tu-95MS bombers launched Kh-55 cruise missiles at their target at a range of about 400km. The target was represented by an area, designated in the open Arabian Sea. The launches were quite successful.

Some 14 hours after the targets had been engaged all aircraft returned to their home bases. On the ground the crews, which had participated in the combat sortie, were met by eager relatives with flowers, long-range aviation veterans, and their colleagues, with a military band playing in the background.

Veterans, who observed aircraft returning from their mission, recalled with pride, and at the same time with sorrow their past, when several regiments, comprising hundreds of heavy bombers, would take off from an airfield at an interval of several minutes. As an example, they recalled the Udar 71 and Udar 73 training exercises, when almost the whole of Soviet aviation was scrambled, including air forces of the Warsaw Pact member-states (the then counterbalance to NATO). This air armada, incorporating about 4,000 to 5,000 aircraft, controlled by a single command post, would then gather and head for the area specified. On reaching the target, the armada would turn back and break its formation, while aircraft would fly back to their respective home bases. It was very impressive.

It took several days in advance to prepare strategic bombers for their flight towards the Indian Ocean. Commanders worked out several flight routes, obtained permission to fly through airspace of foreign states, and prepared flight personnel, aircraft, and armament for the mission.

On the eve of the exercise the commander of a heavy bomber division, deployed at the Engels airfield outside Saratov checked readiness of air crews and then informed them of their objectives. After that the airbase quieted down until the H-hour, and silence settled over the airbase in the middle of the day. Everyone was getting ready for the long flight and for discharging the combat mission in foreign skies.

Deep into the night the airbase changed drastically, with everyone suddenly running about their tasks: preflight briefings, handing out sidearms ... Finally, crews climbed into their aircraft.

In the small hours of a May morning the horizon of the southern sky splashed with colours of the coming dawn. The rumbling noise of aircraft engines rolled far into the grassland.

At half past five in the morning the first two Tu-160 strategic bombers took off effortlessly and gracefully, like giant white birds, and vanished into thin air. The task of reconnoitering the route and launching tactical missiles was still ahead of them.

An hour later they were followed by four Tu-95MS bombers, carrying cruise missiles, which leisurely ambled into the skies. The group headed away to fulfill its mission. Another hour later the aircraft crossed the state border and entered foreign airspace. Yet another several hours later, exactly at noon, crews of two Tu-95MS bombers, headed by Deputy Regiment Commander Lieutenant Colonel Vyacheslav Kuznetsov and the second-in-command of the squadron Lieutenant Colonel Igor Gorlov, launched two Kh-55 air-to-surface cruise missiles.

The bombers launched cruise missiles in cooperation with a battle group of Russian combat vessels, deployed in the Arabian Sea. The battle group comprised nine surface ships of the Russian Navy, including the Moskva missile cruiser in service with the Black Sea Fleet and the Marshal Shaposhnikov and Admiral Panteleev ASW ships in the inventory of the Pacific Fleet. The ships in question transmitted target designation data to the Tu-95MS bombers, and then assessed accuracy of fire.

The command post exercises were supervised by Colonel General Vladimir Mikhailov, the Russian Air Force Commander, who controlled the exercise from the Air Force Central Command Post, situated outside Moscow. The Commander highly appreciated navigation skills and combat readiness of flight crews of the Tu-95MS strategic bombers in service with the Russian Air Force.

Major General Igor Khvorov, the commander of the 37th Strategic Air Army, said: "I am satisfied with the results of missile launches. All targets have been destroyed with precision specified, while air crews operated precisely, correctly, and professionally".

Russian Defence Minister Sergey Ivanov stated that "it was the first time the joint exercises proper, which saw participation of both the Navy and the Air Force, represented by the long-range aviation, were carried out in that region, while no such exercises had been carried out during the Soviet times". Under the Air Force combat training plan, all units and personnel of the Long-Range Aviation are to undergo combat readiness inspections in 2003.

In the meantime the bombers returned to their home base.

The two Tu-160s were the first to land. 14 hours after the takeoff the last aircraft touched down and taxied to its parking area, where tired but happy flight crews were met by their regiments in formation, sporting their colours, as well as welcomed by relatives with flowers.

While aircraft commanders were reporting the results of their mission, new red stars were being pained on still warm fuselages to symbolise missiles launched.

Oleg LITVINOV

CENTRAL COMMAND POST

KEY ELEMENT OF RUSSIA'S AIR DEFENCE

Following more than forty years of lull after a US Air Force reconnaissance aircraft was shot down over Soviet territory, U-2 spy planes have been spotted near Russian borders again. This time the aircraft was operating in Georgia's airspace. Russian Air Force Commander Colonel General Vladimir Mikhailov said that a U-2S spy plane flew along the same route on 27 February and 7 March at a distance of 20-35km from the Russian border. Another U-2's sustained flight along the border of the Russian Federation was registered on 22 March this year. The US side claims that the missions have been performed in order to identify international terror bases. The Russian Ministry of Foreign Affairs, for its part, insists that activities of the kind are likely to cause further tension in the region sensitive as it is as far as Russia's national interests are concerned. Representatives of the Russian Defence Ministry expressed their concern, too. The Russian military said that the flight of the US spy aircraft was monitored from the ground, two Su-27 fighters called on to prevent possible violation of state border.

Servicemen of the Russian Air Force Central Command Post based in the vicinity of Moscow were the first to know about the US planes prowling along the Russian border, two Su-27 fighters taking off on command of the duty officer. The facilities of the Air Force Central Command Post are used to monitor air traffic in Russian airspace, corresponding decisions made in case any violations are registered. The author of the article was lucky enough to visit the sanctum sanctorum of the Russian Air Force and see for himself operation of its facilities, one of the most sophisticated assets of the Russian Armed Forces.

To get to the technical zone of the post, one is to go through seven doors. Comprehensive data on what is going on in Russia's airspace, from some remote areas to Moscow, is transferred to the post through open and closed channels. Central Command Post officers handle violations of the Russian state border and prevent illegal activities of aircraft of all types.

Every day at an appointed hour several hundred servicemen and civil experts, both men and women, head for an inconspicuous building located among swamps and forests in the Moscow region, to come out of it a day later. The routine has been practiced for forty years now.

Let us follow these people. The first door opens. Humming of invisible machines on, we are now entering the Air Force Central Command Post, one of the most secret facilities where no reporter has ever been allowed before.

Major General Akhat Asadullin, head of the Air Force Central Command Post and Deputy Chief of Air Force Headquarters in charge of combat training, is meeting us. Accompanied by the general, we proceed to the first armoured door leading down to the bunker.

After a thorough inspection of our passes we are granted access to the technical zone. A high-speed elevator takes us deep underground. For a moment or two you feel zero gravity, following which rapid speed of the elevator and great drop of altitudes make your years ring, and you lack fresh air. Some thirty seconds later the elevator stops softly. The doors slide open and we find ourselves at a depth of over 120m underground in a dim corridor that seems to have no end, its length mounting up to more than 1km.

During the descent Akhat Asadullin tells us that the technical zone of the Central Command post, a concrete bunker in its essence, is a complex engineering structure, its design similar to an underground station and an orbital station at a time. All the facilities of the zone, ranging from air-tight multi-tonne doors opening with a hand and cutting-edge automatic command systems, are absolutely unique and matchless.

After a short walk along the corridor we get into the spacious room of the Combat Control Hall, the main module of the technical zone.

The Combat Control Hall houses automated work stations of the duty general and his assistants. Air situation over the country and near its borders is indicated real-time on computer monitors, plotting boards, tables and a huge display, its dimensions similar to those of a cinema screen.

According to Head of the Central Command Post, in peacetime the post is to ensure uninterrupted command and control over the Air Force duty forces. It is to perform several important tasks providing for upholding the required level of Air Defence combat readiness, ensuring constant radio and radar reconnaissance aimed at

timely detecting preparation or start of an air invasion, exercising radar control over aircraft and rendering assistance to them in case of emergency, supervising operation of Air Defence duty officers appointed from various branches and services, as well as duty forces and assets of CIS nations, the principal objective being protection of air borders of the Russian Federation.

In February 1998, after merger of the Air Force and Air Defence forces into the Air Force of the Russian Federation, the command posts were merged, too. The Russian Air Force Central Command Post was set up on the basis of the former Russian Air Defence Central Command Post.

Construction of the underground command post began as far back as the 50s. In 1962 Moscow-based Metrostroi completed the facilities. The principal sector of the Central Command Post is accommodated in an underground multi-layer structure fitted with communications assets, automated control systems, computing facilities and survivability systems enabling officers to operate independently for more than ten days. The maximum number of people on mission in the underground shelter mounts up to over 1,000 servicemen. A token border marker is one of the local specialties.

The alert General and Maj.Gen. Akhat Asadullin, head of the Air Force Central Command Post

The Air Force Central Command Post is the principal facility used by the Air Force Commander to control the Air Force in peace and wartime, and he does not have to be underground in the technical zone all the time.

Speaking of his subordinates' service, the general tells us about the 24-hour operation of officers on combat duty in peacetime. The team headed by the duty general includes servicemen responsible for directions and heads of duty shifts.

In case of emergency, the duty general is to assess air situation and take decision on employment of air defence assets. He can justly be considered to be the most active element of the post's team.

Most of the personnel at the Central Command Post have served with Air Force units and formations as combat command officers. Experts of Air Force Command posts, including those operating at the Central post, are trained at Gagarin Air Force Academy, Yeisk branch of the Krasnodar-based Air Force College, St. Petersburg branch of Air Defence University, and Yaroslavl-based Air Defence Missile College.

Analysis of the post's operation in 2002 showed high intensity of efforts aimed at guarding Russia's airspace that grew by 30 – 50% in some aspects as compared with similar indexes for 2001. For instance, in 2002 radar data on more than 150,000 aircraft was handled, marking a 1.5 increase as opposed to the similar period last year. Some 1,000 combat aircraft of non-Russian nationalities, including 350 spy planes, were detected and tracked. To prevent possible air invasion and on command of the post's duty general, fighter aviation was put on red alert for 600 times, anti-aircraft missile forces for almost 200 times, and radio assets for over 2,500 times. Fighters on combat duty were called on to prevent possible abuse of Russian airspace for some ten times.

Unfortunately, the number of violations of air traffic regulations seems to be on the increase, some 40 cases registered last year.

For instance, on 24 May 2002 an An-12 cargo aircraft (side number 11124) of the Russian Aerofrakht airlines penetrated into Russian airspace on its way from Istanbul to Domodedovo without prior notification of Air Force and Air Defence units, which in itself is a violation of Article 31 of the Law on Russian State Border, as well as Air Traffic Regulations of the Russian Federation, specifically, Article 55 Paragraph C,and Article 76 Paragraphs A and F. Despite the fact that the aircraft was denied access to Russian airspace by the Unified Air Traffic System of the Russian Federation, the commander of the plane made up his mind to cross the border. Reacting to the violation, the duty general at the post decided to have the aircraft's route altered and make the plane land. For this purpose a duty MiG-29 fighter of the Russian Air Force Fighter Guard Regiment was called on from the Kursk airfield. Actions of the An-12's crewmembers jeopardized lives of people and caused damage to State property. Unfortunately, no legal standards provide for material liability of the culprits, so the loss was never redeemed. This is a typical example of what servicemen of the Air Force Central Command Post encounter every day in the course of their operation, strain and tension being only too obvious.

...And next day at dawn to the sounds of the Russian national anthem another team of duty officers go underground to the concrete bunker, ready to act on combat order to protect State border of the Russian Federation. For the next 24 hours these people will be engaged in collecting and assessing information on situation in Russian airspace, protection of Russian citizens being the principal objective. Their combat duty is underway again.

Oleg LITVINOV,
Russian Air Force Press Service

SU-27SK FIGHTER UPGRADE:

OLD-TIMER'S NEW CAPABILITIES

For more than a decade now Su-27-series aircraft have been one of the biggest sellers on the international market of modern fighters. Export career of the aircraft began in 1992 with the first batch of the aircraft delivered to the People's Republic of China. Since then some two hundred Su-27/Su-30 fighters have been sold abroad, the largest share of the exported aircraft made up by the products of the Komsomolsk-on-Amur Aircraft Production Association (KnAAPO).

This year KnAAPO has scored 50 years of operation on the international arms market. Su-7B fighter bombers and, subsequently, Su-22 aircraft were extensively employed by armed forces of many nations all over the world. Back at that time the plant was the USSR's largest combat aircraft exporter; more than 2,000 Su-series fighters have been delivered to some two dozen countries over the recent 40 years.

The Su-27 fourth-generation fighter, along with its derivatives, has been the principal item of the enterprise's production programme since the mid-80s. All the Su-27 single-seaters in service with the Russian and CIS air forces were manufactured by KnAAPO. Apart from that, the enterprise is now engaged in building Su-33 deck fighters making up the core of the aircraft complement of the Admiral Kuznetsov heavy aircraft carrier. The fleet of Su-27SK single-seaters employed by some African and Asian nations was, too, produced by the plant. In the late 90s manufacture of Su-30MK multi-role two-seat fighters was started specifically for export needs; combat capabilities of the aircraft are similar to those of 4+ generation assets.

Some features of the Su-30MK fighter have been recently introduced into the Su-27SK single-seater's design, which improved the aircraft's combat efficiency in an air-to-air mode and enhanced its air-to-surface capabilities. Work on upgrading the Su-27 fighter was started last year on order of the Russian Air Force. In the course of the programme, experts of the plant upgraded the head Su-27SM aircraft in service with an Air Force unit, its maiden flight taking place on 26 December. Most of the Su-27 fleet currently employed by the Air Force has been scheduled for modernisation by the KnAAPO enterprise.

Experience gained in upgrading Su-27SMs was later employed in modernising the export single-seat version of the series offered for sale under the designation Su-27SK. Upgraded within short terms, the head Su-27SK single-seater, side number 305, started its flight trails in early 2003.

The most significant features of the fighter as compared with the mass-produced Su-27SK are:

- upgraded fire control system, enhanced capabilities in engaging airborne, ground- and sea-based targets;
- new cockpit indication system based on multifunction LCDs;
- improved navigation system integrated with the Glonass and Navstar satellite navigation systems;
- new ELINT system ensuring efficient employment of anti-radiation missiles;
- new optronic sighting system featuring an additional mode for employing air-to-surface missiles with semi-active laser homers;
- a wide variety of air-to-air and air-to-surface weapons, including missiles with various guidance systems capable of destroying ground- and sea-based targets;
- in-fight refuelling system;
- automated feeding flight mission data into the avionics units, new means of controlling operation of the aircraft's units and assemblies, task-control assets;
- better serviceability of the aircraft.

The upgraded fire control system of the Su-27SK aircraft is made up with two main subsystems, specifically the SUV-VE air-to-air fire

control system also enabling employment of anti-ship missiles with active radar homers, and the SUV-P air-to-surface fire control system featuring an additional function of feeding data to the cockpit multifunction indicators.

The SUV-VE sub-system is a further derivative of the SUV-27 fire control system employed on Su-27SK fighters. The new asset differs from its predecessor in having an upgraded RLPK radar sighting system, a new OEPS optronic sighting system and improved SILS-27M head-up display. The upgraded RLPK system of the new aircraft excels the radar sighting system of the Su-27SK in having an additional air-to-surface channel. The new asset, among other things, can be integrated with RVV-AE and Kh-31A missiles. It has a special programmable digital signal processor, two-channel digital receiver and special computer used specifically for the purpose.

The SUV-P sub-system based on standardised high-speed computers ensures efficient employment of a great variety of air-to-surface weapons, the SUO-30PK system used to control the armament. SUV-P also includes a special flight data feeding device with a programmable module.

The data presentation system in the upgraded Su-27SK's cockpit is based on two multifunctional liquid-cristal displays, multifunction LCD control panel, and a modernised HUD. These indicators are used for displaying graphic and digital sighting, flight and navigation data, as well as information on operation of the aircraft's units and assemblies. Traditional electromechanical indicators have been retained on the instrument panel as back-up assets.

Su-27SK's armament suite has been subjected to substantial changes, too. Along with R-27ER1 and R-27ET1 medium-range and R-73E dogfight missiles, the aircraft is now capable of employing RVV-AE medium-range air-to-air missiles with active radar homers, one of the world's best aircraft killers. An upgraded Su-27SK fighter can carry up to six missiles of the type.

To engage ground-based targets, the Su-27SK, apart from unguided munitions, has four Kh-29T (TE) and Kh-29L short-range missiles featuring TV and laser homers respectively. The armament suite of the aircraft also includes four KAB-500Kr or one KAB-1500Kr guided bombs with TV correlation homers. For anti-radar missions the aircraft can be fitted with four Kh-31P missiles with passive radar homers; four Kh-31A anti-ship missiles with active radar homers can be employed against hostile ships.

Better capabilities of the aircraft's avionics, and weapons suite enhance Su-27SK's efficiency in an air combat and in countering ground- and sea-based targets. The upgrade package turns the aircraft into a 4+ generation fighter making a good match to the best aircraft of foreign make. Diversified options offered by the Sukhoi company and KnAAPO provide for deliveries of both Su-27SK upgraded single-seaters and Su-30MK multirole two-seaters, which could scale down the customer's expenses on forming national air forces fleet with cutting-edge aircraft. In addition to that, the experience of modernising Su-27 fighters of the Russian Air Force and upgrading the Su-27SK No 305 aircraft by KnAAPO offers an ample opportunity to modernise in-service Su-27SK fighters up to the 4+ generation level with customers' time and expenditures minimised.

Andrei FOMIN

"I AM POSITIVE THAT WE WILL HAVE AT LEAST ONE YAK-130 SQUADRON IN 2005"

This was what Colonel General Vladimir Mikhailov, Commander-in-Chief of the Russian Air Force, told journalists at the 30 May 2003 rollout of the first production Yak-130 combat trainer. The ceremony was held at the airfield of the Nizhny Novgorod-based Sokol aircraft plant.

The commander-in-chief was long studying the cockpit, with test pilot Roman Taskaev providing explanatory remarks. Colonel General Mikhailov then slowly walked round the jet, stopping to look into the nozzles and air intakes; only after that did he approach the journalists.

"The aircraft is very beautiful, both inside and outside. It is a keen pleasure to sit in the cockpit," he said. "I am positive that we will have at least one Yak-130 squadron in 2005. This squadron will not just operate these new Russian aircraft, but will use them for cadet training."

The production aircraft slightly differs from the Yak-130D demonstrator showcased at several major air shows. Redesignated as combat trainer, the Yak-130 got a larger diameter nose to house a radar and wingtip pylons for close-range missiles or electronic/infrared countermeasures pods. The airframe and equipment have also undergone considerable changes.

The integral fly-by-wire control system allows for altering the stability and control parameters depending on the aircraft type being simulated. The system additionally performs the automatic control and active flight safety functions. Cockpit instrumentation has also been rearranged: the trainee's and instructor's cockpits each mount three 6x8in multifunction colour LCDs instead of traditional electromechanical instruments.

An extensively versatile aircraft, the Yak-130 is readily adaptable to the requirements of different air forces in terms of its technical parameters and operational characteristics.

In its trainer role the Yak-130 is a major component of a simulation facility, which also includes computer-aided classrooms, simulators, a piston-powered aircraft (a Yak-52M or a Yak-152) and an integrated control system. This training facility can be used to train pilots fly virtually any fourth- or fifth-generation warplane such as the Su-30, MiG-29, Mirage 2000, F-15, F-16, Rafale, Typhoon, F-22 and F-35.

The Yak-130 combat trainer can be used for covering up to 80 per cent of the entire pilot training programme. Its service entry with flight academies, fighting units and training centres is promising to cut operating costs by 4-5 times and preserve service life of single- and twin-seaters currently used for basic, advanced and refresher training. The Yak-130 can mount virtually all types of Russian-made airborne weapons.

The Yak-130 will be more effective and cost-efficient in local conflicts than contemporary fourth- and fifth-generation warplanes.

Early in its history the Yakovlev design bureau was developing lightweight sports and passenger aircraft. Yakovlev fighters constituted the mainstay of Soviet fighter aviation during WWII; Yaks became the first jet fighters to enter service with the Soviet Air Force. The Yak-40 and Yak-42 passenger jets are well known all over the world. The design bureau used to be at least one decade ahead of international competition in developing STOL: suffice it to compare the Yak-141 to the US-made F-35. Yakovlev will likely implement these developments in designing Russia's fifth-generation fighter.

Yakovlev president Oleg Demchenko kindly agreed to be interviewed for Air Fleet.

Question: Many Russian aircraft businesses have over the past decades abandoned, to different extents, their traditional specialization. The Yakovlev design bureau, by contrast, has kept up virtually all of its R&D lines. How did you manage to do this?

Oleg Demchenko: I believe that is because Yakovlev is Russia's only business that has learned to sell projects rather than assembled aircraft. Back in 1993 we concluded contracts with Israeli and Italian companies; all profits gained from joint design and production in the framework of these contracts were invested into development of our own projects.

Thus, we used the money earned from IAI's Galaxy contract (this aircraft has already hit the market under designation Gulfstream 200) to develop our 30-50-seat Yak-48 passenger airplane.

A contract with the Italian company Aermacchi helped us develop the Yak-130, which won the Russian Air Force tender for a new-generation combat trainer. The Nizhny Novgorod-

based Sokol plant is already building the first production Yak-130s for the Russian Air Force.

Most of money we earn from foreign contracts is invested into development of new projects. Our new Yak-54 sports aircraft has recently gotten certificated; we are investing our own funds into development of the Yak-152 training aircraft intended to replace the Yak-52 basic trainer. Sports aircraft are our long-standing specialization.

We at Yakovlev have long come to realize that the current market situation calls for integration - but not the holding-type integration we are being arm-twisted into: none of the newly emerged holdings yet seems to be operational. This is why Yakovlev has started cooperation with other companies on various projects: jointly with Sukhoi we submitted the winning Russian Regional Jet bid for the Russian state tender; a joint project by Yakovlev and Ilyushin has been submitted for a short-medium-haul passenger aircraft tender, whose results will shortly be announced.

Q: What programmes enjoy priority with the design bureau?

OD: Our top priority programme is the Yak-130; this year we expect to build and test-fly the first production aircraft, with joint official tests scheduled for 2004. The Yak-130D demonstrator got a positive flight performance conclusion two years ago.

Q: What can you say about Yakovlev's relations with the Russian Defence Ministry? How many Yak-130 combat trainers is the Russian Air Force planning to purchase in the near future?

OD: We have already obtained a state contract worth 30 mln rubles from the Defence Ministry. The sum may appear small, but it is just the first order, there are more to come. This contract shows that the Defence Ministry is interested in the Yak-130 combat trainer. The Russian Air Force will need around 250 such aircraft starting in 2007; we expect a state contract for 2004-2005 as well. The initial production batch, which was recently mentioned by Air Force Commander Vladimir Mikhailov, is planned to consist of ten aircraft, but the final figure will be specified in the 2004 federal budget.

Q: When will the Yak-130 enter service with the Russian Air Force?

OD: We hope this will happen in 2004, shortly after completion of the official tests.

Q: Could you name other potential Yak-130 customers?

OD: Algeria, India and Mexico are expressing interest in purchasing the aircraft; we are actively negotiating with respective governments. Following a Yak-130 presentation in India, Russia sent the Indian defence minister an official address, offering the Yak-130 as the winner of the Russian Air Force's tender. We have also held an official Yak-130 presentation in Algeria.

Oleg Demchenko, president, Yakovlev design bureau

Q: The first production Yak-130 will be demonstrated at the 2003 Le Bourget air show, where Italy is likely to showcase its Aermacchi M346 novelty. What are the current relations between Yakovlev and Aermacchi?

OD: I can refer to our relations as fairly normal. On 6 May I met with the Aermacchi president in Rome to discuss prospective cooperation issues.

Under our contract with Aermacchi, Yakovlev's Yak-130 is intended to meet the requirements of the Russian Air Force, whereas the Italian company is building its M346 to comply with the specification of the Italian Air Force. Another difference is that Aermacchi M246 is a pure trainer, whereas the Yak-130 is a combat trainer.

One of the contract paragraphs reads that official tests of the Yak-130 in Russia and M346 in Italy will be followed by discussion of our cooperation prospects.

Q: Is the market already identified for these two aircraft types?

OD: No, we operate in a free market. The only contract term is that Aermacchi has the exclusive right to market its trainer in NATO member nations, and Yakovlev has the exclusive right to the CIS market. In other parts of the world we will engage in free market competition.

Q: Don't you fear such competition?

OD: No, we don't. First, the Yak-130 will be cheaper than the Italian jet. And second, as I have already said, Aermacchi has built a pure trainer, whereas the Yak-130 is a combat trainer.

We are certain there will be a vast market for our jet, with around 2,000 aircraft required until 2015 to reequip the trainer and combat trainer fleet. Competition in this market segment is currently rather low; taking over 20-30 per cent of the trainer and combat trainer market would be enough for us to turn the Yak-130 project into a profitable enterprise.

Q: Unmanned aerial vehicles have gained universal attention after the Afghanistan and Iraq campaigns. Yakovlev has long been developing UAVs. Are you planning to make this R&D line a top priority?

OD: This year the design bureau released a Pchela-1 UAV upgrade, which we hope will soon enter official tests. For the time being we do not bring research and development programmes outside our traditional field of tactical UAVs and small-size strike UCAVs. Investment of own funds helps us keep research efforts on a large scale. One major problem here is there is still no official UAV application concept in Russia. Once such a concept is introduced, we will be able to better understand the potential market needs.

Q: Could you tell our audience about yourself?

OD: My entire life is dedicated to aviation. After the 1968 graduation from Kuibyshev Aviation Institute I worked in Kuibyshev (now Samara) and Kaluga; when assigned to the TMKB Soyuz design bureau, I developed the afterburning chamber for the RD-33 engine and bypass engines for the Moskit anti-ship cruise missile. This was followed by 12 years of work in the Aircraft Industry Ministry, in the posts of assistant chair of the central office for industrial management, chief engineer in the same office and member of the ministry board. Since December 1991 I have been with the Yakovlev design bureau.

ANSAT CERTIFICATION

The Ansat light multipurpose helicopter is currently undergoing certification trials at Kazan Helicopters. Over its six-decade-plus history the Kazan-based enterprise has gained the fame of a leader in the international rotorcraft industry by building numerous modifications of the Mi-1, Mi-4, Mi-14 and Mi-8/Mi-17 helicopters. Its current primary products are the Mi-17V-5, Mi-17-1V and Mi-172 new generation medium multipurpose helicopters, a guarantee of stable profits for years to come.

But balanced economic development calls for perpetual renovation of productive capacities and product range expansion. The Kazan Helicopters management has drawn up a program to design an entire range of new rotor-wing aircraft; the Ansat helicopter with 3.3t takeoff weight is the first machine of this range.

The first Ansat prototype, assembled in 1997, was intended for static endurance tests. The prototype has by now exceeded 800h of ground operating time. The second helicopter, the first flying prototype, was first flown on 17 August 1999 by test pilot V.M.Rusetsky. This machine, which has spent the equivalent of 150h in the air, will be used in further static tests. Kazan Helicopters designers analyzed the results of the ground and flight tests on the first two Ansat helicopters for building the third prototype, which took off for its maiden flight in late 2001. The third Ansat, referred to as the preproductionprototype, is currently used as the baseline model in certification tests. The machine has by now exceeded 80h flight time.

From the very beginning the Ansat project was kept in line with Russiaís AP-29 airworthiness standards, a close analogue to the FAR-29 international standards. A primary purpose of the certification tests currently underway is to confirm that the Ansat complies with these standards.

Along with certification tests, Kazan Helicopters is continuing endurance trials of the new helicopter. Most Ansat components already boast a service life exceeding 500-700h, the only major exception being the rotor drive system with its 300h service life. Engineers believe by year-end they will bring the service life of all Ansat components up to 1,000h, a value comparable to those for analogous foreign rotorcraft.

The certification program was preceded by comprehensive ground tests and preparation of the helicopter. Virtually all systems were modified until the Russian

Aviation Registrar of the Interstate Aviation Committee (AR MAK) finally approved the flight test programme. Flight tests started in October 2002 and continued throughout the winter, strong winds, snow and frost (the temperature would at times drop to -38ºC).

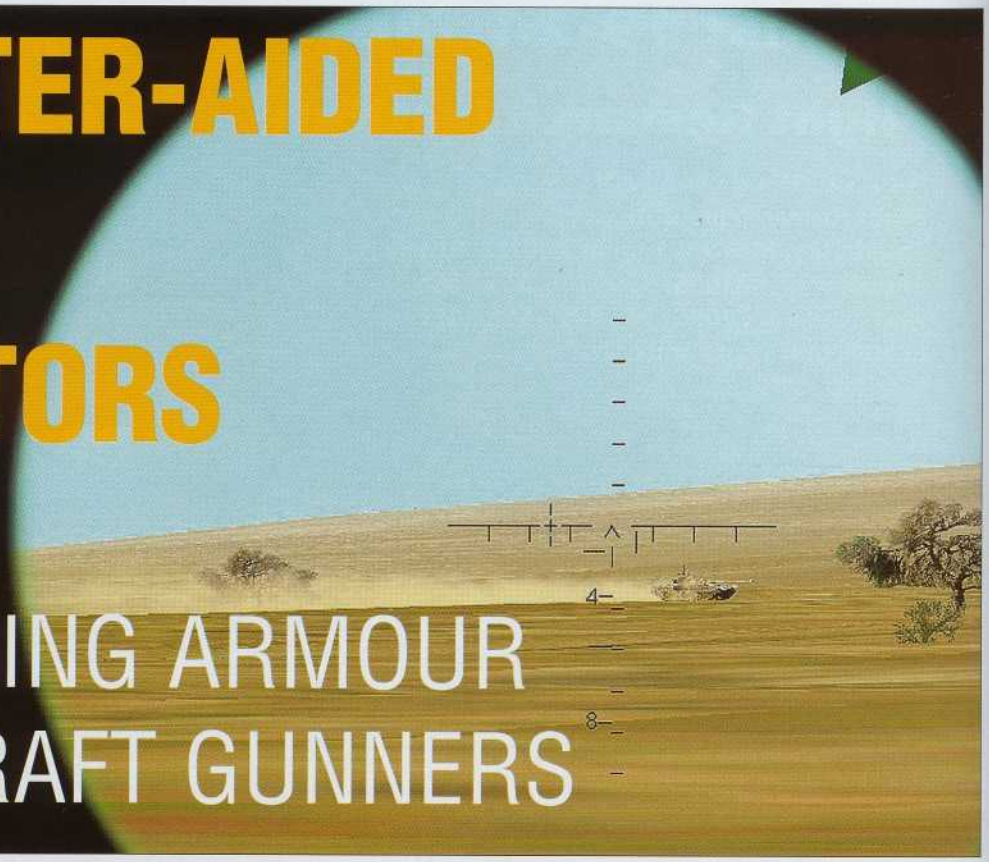
All ground and flight certification tests are being held at the Kazan Helicopters flight test center. The enterprise management is closely monitoring the progress of the certification programme. Every Friday Yu.B. Nedelko, head of the flight test center, gathers meetings in his office; during these meetings V.B. Kartashev Deputy Director General Kazan Helicopters and Ansat programme manager, discusses the programme status with designers, engineers and pilots. This day-to-day management goes a long way towards successful certification. The performance testing phase is nearly accomplished now; the test results confirmed the design parameters and even exceeded many of them. Autorotative landings, the only tests left to run within the programme, were put off until the final phase in accordance with the standard practice.

In January 2003, Kazan Helicopters was visited by a commission comprising representatives of AR MAK, the Central Hydrodynamics Institute (TsAGI), the Gromov Flight Research Institute, the State Scientific Research Institute of Civil Aviation (GosNIIGA) and other national aviation authorities. The enterprise management had invited the commission to state its competent opinion, provide consultations and recommendations prior to the following testing phases. The commission was briefed on the certification progress, approved the results of the first testing phase and adopted the structural testing programme.

The second certification phase, which began in February 2003, saw the third Ansat prototype fitted with strain gage sensors, and onboard instruments calibrated. During this phase, which still continues, the fourth Ansat prototype will be used in testing the fly-by-wire control system, fuel system, oil system, radio equipment, etc. Kazan Helicopters engineers are planning to hold around 150 certification flights and have all the tests accomplished by year-end. Says Mr. Kartashev, ìThe Ansat will enter production immediately after it gets certificated. We already have a portfolio of firm orders, our customers in Russia and abroad are eager to start operating the machine. We are certain of a great future for our helicopter.î

Vadim MIKHEYEV

COMPUTER-AIDED FIRING SIMULATORS



FOR TRAINING ARMOUR AND AIRCRAFT GUNNERS

International commitments of the KBP Instrument Design Bureau require a balanced support of products manufactured throughout their service life. However, while arms development, production, and marketing are customary practice for the afore-mentioned enterprise, training foreign personnel and providing after-sales maintenance press for totally new approaches.

Contemporary computers and 'virtual reality' technologies open vast vistas for developing training simulators and computer-based documentation for a whole range of products. Development of computer-aided gunner's simulators, designed to train combat crews of all types, is one of the workstreams embraced by KBP. The simulators in question are designed for combat crews to master crucial combat skills such as homing the fire control system (FCS) in on the target, and firing various weapons.

At the present time the enterprise has developed the following computer-aided firing simulators, designed to train gunners of various missile and gun systems:

1. ATGM gunner simulators with mobile and stationary launchers.

2. Tank and IFV fire control system gunner simulators, capable of simulating movements of the gunner and the surveillance radar, when the combat vehicle is on the move.

3. Attack helicopter FCS gunner simulators, boasting such capabilities as simulating various fire control systems, and taking into account high mobility of the platform.

Top: Target environment simulation in the armour gunner simulator

The simulators mentioned above are all based on the standard hardware/software package. They facilitate professional selection of combat crew members by using computer-aided psychological testing techniques; support major training stages, aimed at instructing gunners in the skills necessary for combat operations given tough timeframes, caused by the rapidly-changing environment of the contemporary battlefield, including tactical skills of detecting and prioritising targets, selecting the right weapon, aiming and firing it, and killing the target; provide timely assessment of gunners' work; assist in maintaining the required level of combat skills by providing a shorter second training course.

The main feature of gunner simulators consists in simulating a true-to-life mathematical model of the guided weapon system (GWS), which takes into account sequence diagrams of the FCS modes of operation, characteristics of devices used by the gunner, weapons performance, and specifications of various munitions.

The simulators are designed to be employed at military training centres. The nature of the training course envisions a training period of 20 to 30 days. The instructor may introduce changes to the composition, sequence, and specifications of combat missions simulated.

Simulator computers are based on Intel Pentium III CPUs and video adapters, supporting OpenGL graphics standard. It is worth mentioning that if necessary the software used allows multiprocessor or even multi-computer systems to be used, with the latter linked with each other via a high-speed network.

The software, used in gunner simulators, is compatible with Windows 98 and is developed in the Microsoft Visual C++ language. Generally speaking, several units may be pointed out in the simulators' software.

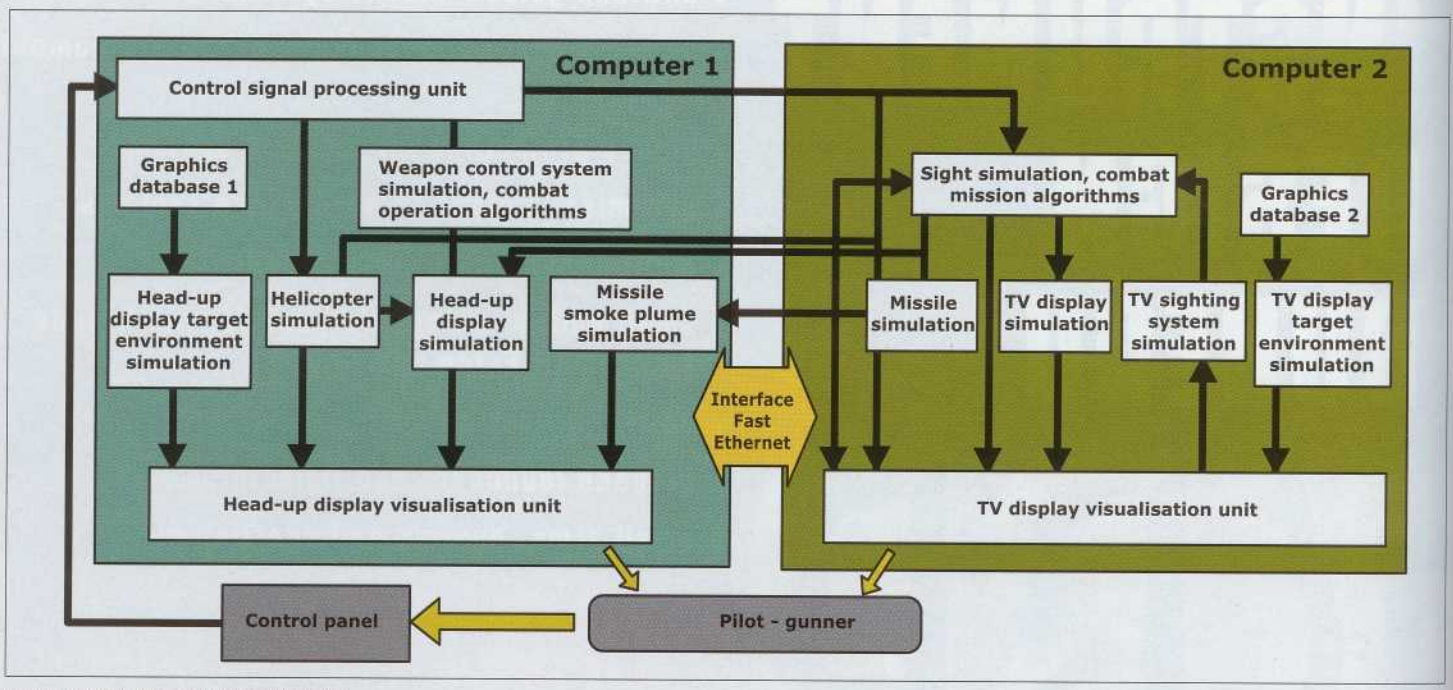
The mission display is based on the SGI OpenGL graphics. It is capable of simulating the sight field of view, taking into account optical magnification, the angle of view, and peculiarities of the sight proper. Weather conditions, terrain, target type, and other parameters are also factored in. The display provides the following:

- geometrical simulation and display of virtual landscapes, including terrain and illumination level, which takes into consideration season, daytime, and a host of stationary (passive) natural or man-made objects, for instance, trees, bushes, and military installations. The simulator is also capable of simulating grain-oriented landscapes, such as prairie, near desert, and desert terrain;

- simulation of mobile (active) enemy targets, for instance, tanks, IFVs, APCs, helicopters, and vehicles. At the same time it simulates various trajectories and kinematics of moving targets, for instance, the turning turret of a tank, or spinning wheels of an APC. The simulator employs 3D geometrical models of targets with a varying degree of specification;

- simulation of dust or smoke plumes, caused by moving enemy armour;

- simulation of devices, used by the gunner: the sight, and the laser range finder. At the same time it simulates optical qualities of the afore-



Layout of the helicopter firing simulator

mentioned devices, and required scales and readouts, which match FCS modes of operation, simulated by the mathematical modelling unit;

- simulation of weapon system effects, taking into account the type of the weapon system and munitions. At the same time it simulates optical effects, caused by a fired round, displays missile flares and smoke plumes, taking into account the direction and the strength of the wind, as well as artillery round trajectories. In addition to that it simulates impact of a round. For instance, if a round or a missile hits the target, it displays the impact point on the target profile. If they miss, it simulates their explosion in the impact point on the terrain surface simulated.

The mathematical modelling unit provides the following:

- real-time reproduction of the FCS logic and timing diagram, as well as transfer of data on the FCS state to the display.

- simulation of environment effects, affecting the FCS aiming (wind, fog);

- control over the FCS, which automatically adjusts weapon systems, as well as weapons stabilisation drives;

- reproduction of the control loop dynamics and simulation of missile trajectories, taking into account the range to the target, terrain features, visible to the gunner, control signals, sent by the gunner via the control panel, as well as the overriding mode;

- simulation of ballistic trajectories of unguided artillery shells, taking into consideration munitions type, range to the target, terrain features, visible to the gunner, and various natural factors.

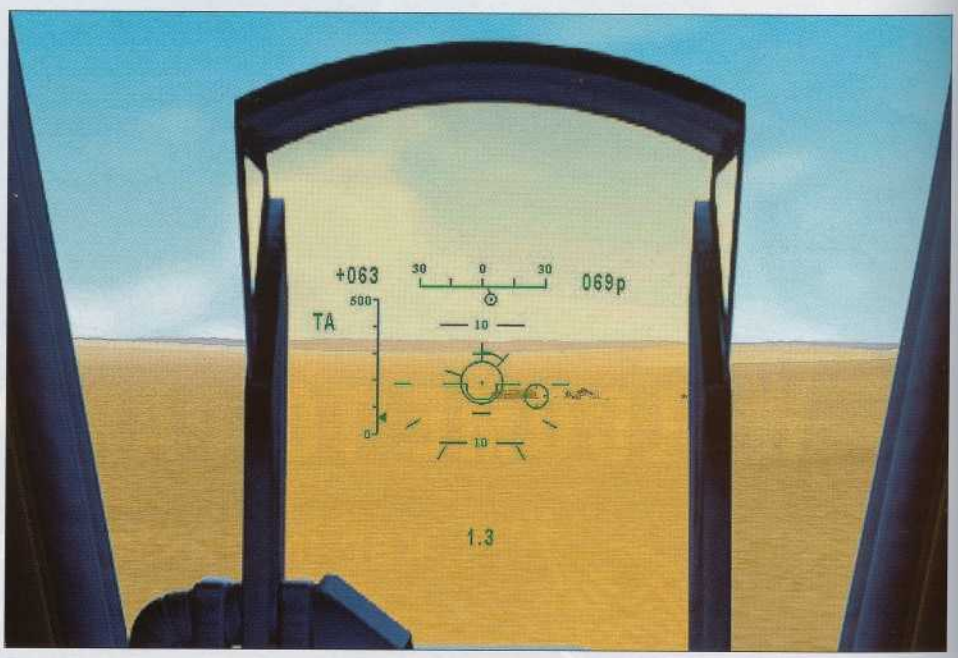
The control signal input and processing unit receives digitally-ciphered control signals, sent by the gunner with the help of the FCS control panel.

The training results recording and processing unit is designed to store parameters of the gunner's operation in the database so that later on they may be analysed and documented. Instructors are provided with a capability of defining and amending the list of gunners, undergoing simulator training, as well as monitoring, analysing, and comparing the results.

Gunner simulators allow resources to be considerably husbanded, as their employment considerably reduces the firing-range stage in the GWS crew training course, and enables gunners to use the "electronic firing" technique, which boasts neither expenditure of expensive ammunition, nor wear of weapon systems. Besides, they drastically raise the standard of crew training due to a more intensive training.

The KBP Instrument Design Bureau has developed powerful tools and equipment in order to design the afore-mentioned simulators. It was this very same versatile equipment that helped successfully develop other computer graphics applications, for instance, a computer-simulated battle of opposing armour units. Computer graphics are expected to be further improved due to the development of the artificial intelligence and geo-informational system units. For instance, experts plan to develop the mode of automatic routing for armour in the virtual terrain, as well as means to simulate target 'behaviour'.

Andrey MOROZOV, Evgeny KACHAYEV, Vitaly DAVYDOV, Viktor TARASOV, Sergey PYATNITSKY, Valery PONYATSKY, Evgeny RESHETNIKOV, Vladimir KHUDYAKOV

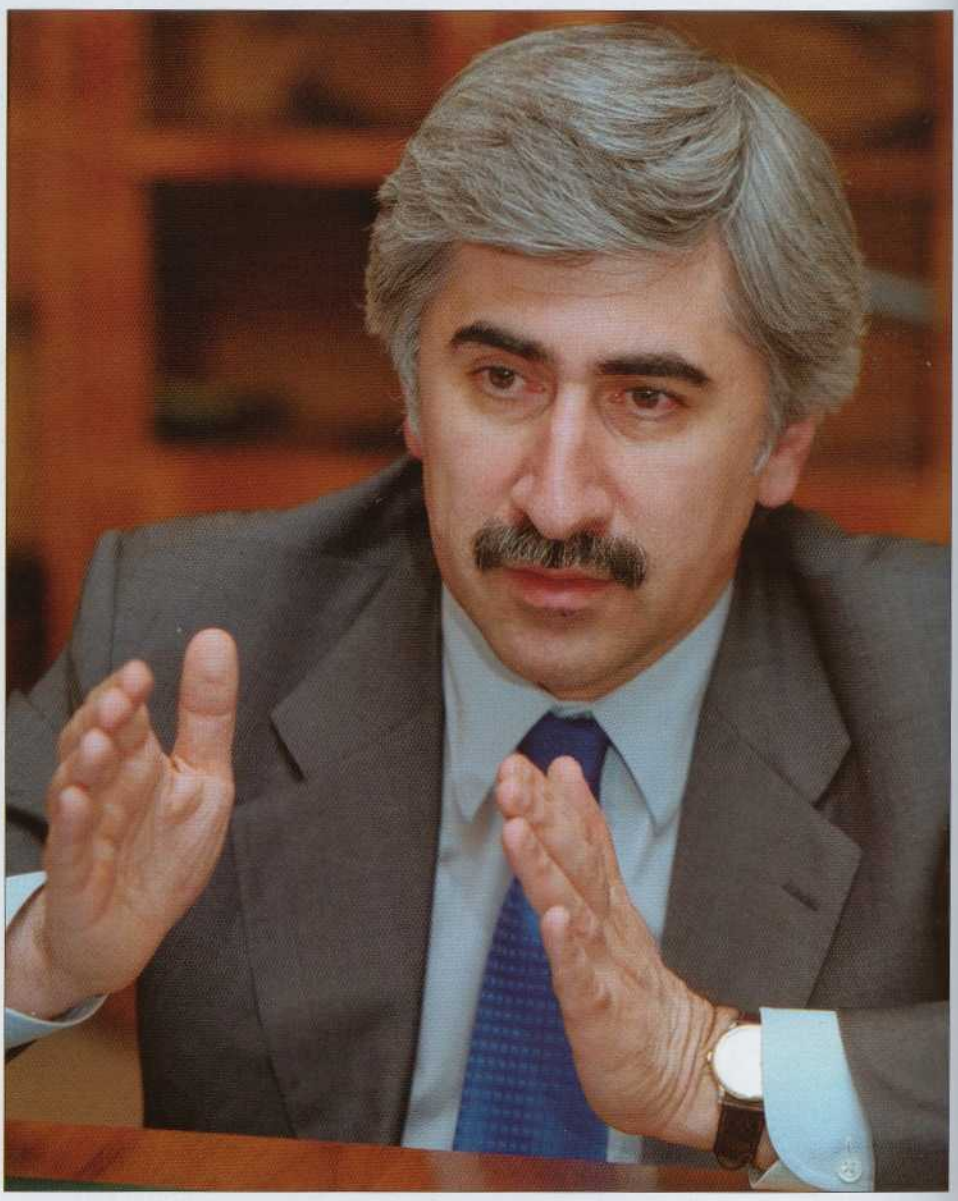


Target environment simulation in the helicopter firing simulator

MIKHAIL POGOSYAN:

WE ARE OFFERING HIGH-QUALITY, ATTRACTIVELY PRICED PRODUCT

Air Fleet interview with Mikhail Pogosyan, AVPK Sukhoi Director General



Air Fleet: What is your view of the optimal balance between the civil and military produce to be output by Sukhoi's enterprises in future?

Military equipment currently accounts for over 95 per cent of the company's output. We believe this balance should change through diversification, although the military component will prevail in the near future. In fact, production of military equipment will amount to 50-55 per cent of the overall output volume, with aftersale services reach another 10-15 per cent; we will gradually build up production of civil equipment to bring it up to 30-35 per cent of the total output for more stable business activities despite the ever-changing pricing environment and oscillating demand for military products.

Air Fleet: The Rosaviakosmos Russian Aerospace Agency has declared the RRJ bid by Sukhoi Civil Aircraft the winner of the Russian state tender for development of a new regional jet. Could you please tell our audience about the planned cooperation in this programme and its major phases?

Indeed, Sukhoi has won the tender for developing a family of regional jets. In the framework of this project we are planning to join efforts with Ilyushin and Yakovlev, Russia's traditional developers of civil aircraft. These companies will cooperate to an extent that is currently being finalised. The major foreign parties are Boeing and Snecma Moteurs, a partner of NPO Saturn.

We will form joint workgroups to include Russian and foreign manufacturers of all RRJ systems; this is our primary approach to implementation of the project called to attract foreign partners in possession of cutting-edge technology solutions for separate systems, and also to enable international certification of the RRJ. As for Russian partners, they will introduce advanced Russian technologies and help reduce production costs owing to the fact that development and manufacturing services are cheaper in Russia than abroad.

We believe that a major part of project work must be carried out in Russia, with Boeing participating mainly by way of introducing technologies for development, production, marketing and aftersale support of civil aircraft. Boeing is, therefore, providing intellectual support in this project. We need workgroup participation of Boeing specialists for maximum use of that company's vast experience in development of civil aircraft.

But it is our priority to have most of work on the airframe performed by Russian partners. This is the prerequisite for a low product cost which, in turn, will precondition successful market promotion and, ultimately, commercial success of the project. We are also seeking around 50/50 cooperation between Russian and foreign partners as regards work to develop onboard systems.

Air Fleet: Have you considered the possibility of establishing a consortium for this project?

We have, indeed, discussed such a possibility but arrived at the conclusion that the optimal

solution would be having Sukhoi Civil Aircraft as the directing agency for the project. The company will further develop and transform, probably incorporating new investors and partners with time.

Air Fleet: Does this mean that work on the project will be mainly based on bilateral agreements?

You are right, but these agreements envision participation of several partners that would share the project risks and invest their own funds into development of the entire programme and its separate phases. Sukhoi Civil Aircraft, therefore, is not merely the customer and chief investor in this project; we are building a cooperation team around \partners that will share the project risks and investment with us.

Air Fleet: What may be the extent of Yakovlev's and Ilyushin's participation in this project?

We have not yet reached any final agreements on this issue. Sukhoi is currently carrying out the major part of project work, but we are negotiating with the Ilyushin and Yakovlev design bureaux over their participation. Ilyushin is a partner in organization of RRJ certification; \its specialists will also be included into our workgroups. We are negotiating with both companies over their designers' participation in development of separate units. The final decision will depend on what resources our partners have and how they employ these resources in other programmes.

Air Fleet: What enterprises will take part in production of the RRJ family?

We are primarily intent on using our own production facilities in production of the aircraft. Our reserve capacities at the Novosibirsk Aircraft Production Association are now operating free of any major military orders, so we believe the enterprise will make an excellent leading manufacturer in this programme. NAPO is well prepared for this role: the enterprise already has experience in production of civil aircraft, namely the An-38 airplane. Its experience of production certification may be of great use in our project. In addition, we are planning to engage the Komsomolsk-on-Amur Aircraft Production Association (KnAAPO), with its high-level equipment and stable financial position, in production of separate units for the aircraft. We will certainly consider cooperation with other production enterprises, and will discuss relevant proposals by Ilyushin and Yakovlev; it is possible that other partners will join in on the programme. NAPO is expected to be charged with final assembly of the aircraft.

We are planning to introduce a novel approach towards demonstrator construction: demonstrators will be built at production enterprises, but the way of interaction with these enterprises will change. Already during the design phase we will closely interact with manufacturing engineers and production managers to better address the peculiarities of the project and different technological specialization of different production enterprises.

Air Fleet: Such a large-scale programme certainly requires sizable development and pre-production investments; some quote the sum of around $600 million. What will be the primary sources of financing?

You are correct, the programme will cost around $600 million. Money will come from several sources. We certainly expect the state to assist financially, especially what regards pre-certification efforts. The programme will also be financed by Sukhoi's own assets, and those of our risk-sharing partners. We have corresponding agreements with Boeing, Snecma Moteurs and NPO Saturn, but their terms are confidential, so I would rather not reveal any details.

A third source of funding will be advance payments on firm orders. We will only launch full-scale RRJ production after landing firm orders from carriers, so we expect the programme funding to include advance payments on future contracts. We are planning to use this money for preproduction purposes.

Finally, our tough project schedule may move us to apply for loans in the final phase. We are planning to have the certification programme accomplished inside one year. With such tough deadlines we might as well borrow money. Participation of international companies and orientation towards international certification creates good conditions for attraction of foreign investments.

Air Fleet: What is your assessment of the market capacity for RRJ family aircraft?

Judging from numerous marketing studies, including those by independent analysts, the market niche for regional jets seating 60 to 100 passengers will be one of the most dynamic segments in the next two decades; experts set the overall production of such aircraft at 5,000 pieces within 20 to come.

We believe the failure of Fairchild Dornier to secure a position in the regional jet market is a favourable condition for bringing a new product up to that market. We think a timely product meeting international standards would be a good competition to products by Embraer and Bombardier in this market segment. We expect production of the RRJ family to amount to around 600 aircraft; one half of this figure will be sold in Russia and CIS countries, and the other half promoted in the international market.

I should stress that the market capacity and success of the programme largely depend on the fact that we are offering a family of aircraft. If we chose to develop an airplane seating just that many passengers, then the planned market capacity would be sufficiently lower, and this fact would impede attraction of investments and hamper recoupment of the programme. Now that we are offering a family of aircraft varying in passenger capacity, we are able to slash the development, tests and preproduction costs, reduce expenses on the entire programme and increase its competitiveness.

Air Fleet: How are you promoting the project among potential customers?

As reception of firm orders is a key condition of the programme success, we are actively working with carriers, first of all Russia's largest airlines, and have already signed corresponding protocols of intent with Aeroflot, Siberia Airlines, Pulkovo, UTAir and Krasair. As for foreign carriers, we are actively negotiating with Air France. At the Le Bourget air show we are planning to hold a conference to present the RRJ project to carriers for the purpose of expanding the number of potential customers.

Air Fleet: Does this mean that you are mainly oriented towards the European market?

No, we are aiming at a wider aerial representation of potential customers. We hope for an order from Air France, but also expect other Sky Team alliance partners, such as Air Mexico, to get interested in our programme. In addition, we

believe our aircraft have good prospects in India: we will develop cooperation with the Indian aircraft industry in an effort to jointly promote the RRJ project to the Indian market. We are making an aircraft for the international market, and will avail of our regional advantages, including those in South-East Asia, and also advantages and contacts that our partners can offer. Snecma Moteurs, for example, is actively participating in contacts with Air France.

The principal success of this project is that our product, while corresponding to prospective international requirements, would be priced lower than those offered by the competition. This success rests, firstly, on the fact that we are offering an entire family of regional jets, and secondly, on cheaper workforce and design capacities that can be found in Russia: this factor enables us to offer competitive prices in the international market.

Air Fleet: Do you mean to say that RRJ aircraft will come with price tags more attractive than products by the Brazilian company Embraer, which has until now saw low prices as one of its major advantages?

Yes, I do. Embraer imports virtually all components for its aircraft: it does not manufacture engines and avionics, so the company has a lower share of own work than Sukhoi. In addition, Embraer was forced to scratch-build many of its production capacities, hence the necessity for embedding production development expenses into the price of its products. Most of production facilities and equipment we are planning to use already exist. We will certainly reequip our production, and the overall $600 million programme cost includes around $100 million for preproduction purposes, but our production facilities are largely prepared for implementation of this programme as it is.

Air Fleet: There are at least two other regional jet programmes in Russia and Ukraine: the Tu-334 and An-148. What, in your view, is the advantage of the RRJ project?

Our approach principally differs from the Tu-334 and An-148 programmes. Firstly (I never tire of highlighting this critical factor), we are developing a jet family. Anyone opting for development of a single aircraft type with a fixed passenger capacity can only expect a market capacity of around 100-150 airplanes. Secondly, our project was aimed at international certification from the very beginning. And thirdly, our partners are international leaders in their respective fields. I should stress that engine outfitting efforts and investments by Snecma Moteurs and NPO Saturn are, in our view, key factors of success as compared to a different approach to engine development, when the project is positioned exclusively for the domestic market.

A certain number of An-148s and Tu-334s will undoubtedly sell in Russia and the CIS. But our approach is principally different: in my view, our project is aimed for much wider a market segment, and this factor predetermines the great success of our product.

Air Fleet: How do financial institutions treat the RRJ programme?

Financiers predict a great future for the project, since we cooperate with Boeing and Snecma Moteurs, i.e. the companies which have repeatedly justified the expectations of these financial institutions in the past by bringing them dividends in exchange for financial support of their projects. The advantage of the RRJ project lies with the strategy. We think our strategy is correct. In our opinion, a sevenfold drop in the domestic passenger traffic from the 1990s level testifies to the fact that the domestic market capacity is insufficient for developing a competitive product exclusively for the Russian market. What we need is a project that would be simultaneously positioned for the international market. Another mandatory condition here is that such a product must not merely "meet the international standards": nowadays, we must come up with a product that would be certificated under the international standards. No matter how long we talk about our aircraft meeting the international standards, foreign carriers won't be interested until these aircraft actually get certificated under the international standards.

Air Fleet: Are you planning to have the aircraft certificated simultaneously under the US FAR standards and the European JAR standards?

These standards are largely overlapping, nearly identical. We are planning simultaneous acquisition of the Russian and Western certificates. Rather than create a product first and then try convince everybody it meets the international standards, in the very initial project phase we are attracting Boeing, Snecma Moteurs and other partners to work on certification under the international standards. It is the responsibility of our partners to ensure observance of all procedures required for international certification, from the very beginning of the project. These partners' interest in profits from product sales principally differs from the traditional approach, when we promote a product to the Western market and encounter a hostile reception on the part of foreign companies. In this project, we are working together with foreign partners and will share all the commercial success with them.

Air Fleet: Could you update us on the current programme status?

We have already accomplished the conceptual phase and reached agreement with partners in the programme; we are now halfway through the front-end and detailed engineering phase. Simultaneously, we are actively working with potential customers, since transition to full-scale demonstrator construction will only be possible after conclusion of contracts and placing of firm orders. We are planning to accomplish this work within one year, while continuing the design efforts. We will not start construction of demonstrators without firm orders. We have abandoned the wide-spread approach of first building the demonstrator and then trying to land contracts. If you fail to convince the customer, already during the development phase, that your product is exactly what he needs and that you will observe the programme schedule, then nobody will invest any serious sums into your project. And without investments, you will fail to keep up with the tough product release deadlines.

We believe that the RRJ's planned 2007 market entry is the critical period for commercial success. If we fail to observe the deadlines, then our appraisal of the promotion prospects will be much bleaker. We base our analysis on forecasts for retirement of ageing aircraft from Russian carriers' fleets. If we fail to offer domestic operators an attractive family of regional jets, then they will purchase either Western aircraft or some underdeveloped Russian projects. But we are confident of our success, and believe we will be capable of timely offering an excellent product at a very attractive price.

WE ARE CAPABLE OF FULFILLING ANY ORDER

The Tashkent Aircraft Production Corporation named after V. P. Chkalov (TAPC) has manufactured in excess of 7,000 aircraft since it was established 70 years ago. At the present time the enterprise in question is second to none in the Asia Pacific Region. It is not every state that has had a similar enterprise, boasting such great intellectual, technological, and technical potentials. Thus, the Uzbek government has resolved to preserve its largest enterprise with its enormous staff. This decision has also been influenced by the fact that Uzbeki President Islam Karimov and Prime Minister Utkir Sultanov used to work at the afore-mentioned aircraft plant.

Air Fleet asked Vadim Kucherov, TAPC Director General, to tell its readers about the giant plant, celebrating its 70th anniversary this year.

The Tashkent-based aircraft plant used to be called 'a city within a city', and even nowadays it astonishes everyone with its size.

TAPOiCh dates back to 20 November 1941, when Uzbekistan's capital city started receiving trains, loaded with equipment and people, evacuated from Khimki, a town outside Moscow. Just a month and a half later the new production site assembled its first aircraft, the result of painstaking efforts.

Repair plant 84 of the Civil Air Fleet (later on the aircraft plant was named after V.P. Chkalov) was founded in 1932. The plant happened to be connected with transport aviation from the very outset. In 1939 the enterprise started manufacturing the PS-84 (Li-2) passenger airliner. Mass production of the aircraft in question continued in Tashkent. About 4,500 aircraft like that had been manufactured by 1953 and had remained in service until the 1970s.

A considerable part of the enterprise's history is linked with the Antonov Design Bureau. Starting from 1958 the Tashkent-based plant built An-8, An-12, and An-22 military transports. Industrial capabilities of TAPC enabled it to assemble the unique wing of the An-124 Ruslan transport, as well as the wing and the centre wing section of the worldís largest transport An-225 Mriya. Huge units of the An-225 were airlifted from Tashkent to Kiev for the final assembly by a specially equipped An-22.

Mass production of the Il-14 laid the groundwork for effective cooperation between TAPC and the Ilyushin Design Bureau in the mid-1950s. The partnership between the two enterprises peaked during series production of a wide scope of Il-76 modifications. Each modification was designed for a specific purpose, while the plant has produced a total of 950 aircraft of this type. By the way, this April the Il-76 celebrated its 25th anniversary since it made its appearance on international routes. Even at present the Il-76 constitutes the mainstay of air freighter fleets of both private air carriers and air forces in all corners of the compass, operating in most adverse conditions - from tropics to the Arctic and the Antarctic.

However, life goes on, and no matter how good the Il-76 is, it has become a must to develop its new modification, namely the Il-76MF, boasting new power plants and a larger fuselage. TAPC embarked on manufacturing the first Il-76MF prototype in early 1994. In spring 1995 the aircraft rolled off the assembly lines, while on 1 August of the same year test pilot A. Knyshev took the new aircraft for its maiden flight.

On 24 April 2003 TAPC received the final report on the Il-76MF joint state tests. As a result, the authorities arrived at a decision to launch the aircraft into production.

The Tashkent-based plant is ready to manufacture dozens of Il-76MF a year. TAPC began the Il-76MF production as far back as 1995. At the moment the plant has assembled four aircraft, with one of them progressing through flight tests. According to the State Research Institute of Civil Aviation, the Il-76MF may net an air carrier $33 million more, than the ordinary Il-76MD, over a period of 15 years. The Il-76MF is considered to be the primary medium military transport to be fielded with the Russian Air Force in the near future.

TAPC also produces a family of Il-114 local passenger airliners. In April 1997 the aircraft was certified in compliance with the Russian flight standards. However, the Il-114 contracts portfolio was not easy to establish. Potential customers did not fancy the fact that the TV7-117 power plants, mounted on the Il-114, had a shorter service life as compared to that of their US and European counterparts. The situation pressed for an ingenious solution, and at that moment the government provided the plant with a fiscal shot in the arm. The plant carried out a top-to-bottom revision of its marketing system, having meticulously studied that of Boeing and BAe Systems. The national O'zbekiston havo yo'llari air carrier, which had procured two Il-114s, also helped the plant stay afloat, while the Russian Vyborg air carrier has recently started employing the new aircraft as an air freighter.

Contracts secured with such world-wide famous aircraft engine-building companies as Pratt & Whitney Canada, and Hamilton Sundstrand have given the plant a considerable boost. The project of fitting the Il-114-100 with the PW-127H power plant was realised in under a year. As early as late January 1999 the aircraft in question made its maiden flight, while in December of the same year the Il-114-100 was certified by the Russian IAC Aviation Register.

The Uzbek O'zbekiston havo yo'llari air carrier was the first to operate the Il-114-100. The Uzbek national air carrier received one of the three aircraft in January 2003. The aircraft meets all ICAO requirements with respect to flight safety, noise abatement, and emissions level, while insofar its flight characteristics are concerned, the Il-114-100 is capable of competing with its foreign counterparts.

Worth mentioning is the following interesting detail: no matter what foreign air shows they participate in, new Il-76s and Il-114s sport national flags of Russia and Uzbekistan.

When an aircraft rolls off the assembly line, the enterprise is ready to provide maintenance throughout its service life, furnishing the aftersales warranty service, carried out by highly qualified experts, the aftersales maintenance as set out in the contract, conducting overhauls and extending service lives of aircraft (jointly with the designer), shipping spare parts on a short notice, as well as training flight and ground maintenance crews.

The TAPC quality control system was certified to the ISO 9002 standard as far back as 1998, while in 2000 it was approved of by Boeing (with respect to the D1-9000 standard). The facts mentioned above have enabled TAPC to carry out more active international cooperation in the international aircraft parts and units market. For instance, the enterprise has secured a contract with Boeing on producing units for Boeing 737 and Boeing 757 aircraft.

However, aircraft is not the only programme, conducted by TAPC within the framework of Uzbekistan's international cooperation with many countries across the globe. The plant manufactures polymer pipes, using the technique of the German Hobas Company, masters production of aluminium radiators for Nexia cars. The plant has started manufacturing wheel disks for Daewoo cars as part of the cooperation programme with South Korea, besides, TAPC has established the EurasiaTAPO-Disk joint venture, based on the Fergana Engineering Plant.

The enterprise has lots of plans to fulfil. Given tough competition in the international market, raising the quality, and thus the competitive capability, of aircraft produced remains the priority for the plant. TAPC has gained great experience in establishing international links, and conducting market researches, aimed at finding potential customers, and the plant has succeeded in this field.

Given streamlined cooperation links with both CIS member states and foreign countries, at present TAPC is capable of fulfilling any contracts in the sphere of aerospace industry and aircraft-building, even the most demanding ones.

I believe, that the best congratulation for the numerous employees of TAPC would be further development of the enterprise, beefing up its capabilities, and participation in joint investments.

Valery Lesunov, UMPO Director General: "ONE HAS TO SECURE HIS MARKET NICHE"

Air Fleet: What is the current production programme of the plant (the scope of products), and is this programme in for any changes?

Valery Lesunov: At the present time the enterprise's production programme is based on manufacturing defence products. One of the priorities for our company is delivering aircraft power plants to be mounted on the Su-family fighters. UMPO also produces separate sophisticated units for rotary-wing aircraft. In addition to that, the enterprise provides a wide range of aircraft maintenance services: various repairs, spare parts deliveries, and other specific services. The company also manufactures consumer products such as the widely popular Rys snowmobile, employed both for work and recreation, and the Agros multifunctional cultivator, used by gardeners and public services. We constantly diversify our efforts by launching still new products into production, and the year of 2003 is expected to be very intense, insofar the rate and scale of mastering and manufacturing new products are concerned. The enterprise will have to simultaneously set up production of several products. It will keep on mastering the D-436 power plant for the civil aviation, as it is a must to secure a niche in this market. The Tu-334 short-range airliner, and the Be-200 amphibious aircraft, production of which has been authorised by the Russian government, are currently undergoing flight tests. In addition to developing the aircraft-oriented workstream, UMPO will also try to step up production of gas-pumping and gas power-generating equipment. New products are expected to introduce considerable changes to the production programme in the near future.

AF: What is the military-to-civil aircraft production ratio (including commercial power plants, based on aircraft engines)?

VL: At present defence products account for the lion's share of the total output. However, in the future the enterprise expects to bring the percentage of civilian products up to 50 per cent of the total output by establishing a network of gas-pumping stations, operating our power plants, and delivering gas power-generating plants to consumers, as well as manufacturing the D-436 engine.

AF: What is the percentage of exported products and those supplied to the domestic market?

VL: Last year, for instance, the enterprise exported 93.5 per cent of the total product output.

AF: What unique technologies does UMPO possess as compared to other companies working in the same field?

VL: Our enterprise has mastered several dozen unique techniques, other companies do not have, such as the high-speed automatic welding of thin-walled tubes made of high-temperature, age-hardening alloys; ion-plasma nitriding of gas turbine critical parts without the follow-up machining; high-temperature gasostatic treatment of titanium castings; blank forging in the super-ductility mode; welding titanium alloys in the Atmosfera-24 inhabited chamber, featuring controlled argon environment; ion implantation of turboprop and high-pressure compressor blades, etc.

AF: What are the prospects for further development of the enterprise's production capabilities?

VL: We have worked out an efficient programme for improving production capabilities, which envisions active introduction of various innovations and cutting-edge scientific achievements, constant modernisation of production methods and equipment, workstations computerisation, and development of employees' professional skills. Even at the moment our enterprise is capable of manufacturing fifth-generation

engines. UMPO is one of the few companies in Russia to enjoy the complete engine production cycle. We have mastered casting of all materials, used in contemporary power plants, including single-crystal blade casting, isothermal forging and rolling of blades, and precise feed of annular blanks. Where the number of produced machine tools, which at the moment exceeds 17,000 units, is concerned, UMPO is certainly one of the largest Russian enterprises. We constantly analyse the state of our equipment and procure new machines, both from national and flagship European and international companies. However, the company is quite rational about any upgrades: we purchase only things we cannot do without. What is the purpose of unleashing a 'revolution' and replacing 10- to 15-year-old machine tools? When it is necessary to switch on to new techniques for manufacturing 4+ or 5th generation power plants, our company carries out deep modernisation of control systems of 'old' machines, and replaces drives for them to be able to operate in compliance with new techniques. For the most part we do all these things on our own, as we do have excellent contemporary tools, which we try to preserve and upgrade, first and foremost. UMPO is also currently realising the information technologies programme, which embraces the whole enterprise. Our company widely employs CAD/CAM/CAE systems for technological support, engines are tested with the real-time automated data processing, while at the moment the enterprise is introducing the BAAN integrated system into the production control process. We plan on developing and improving all the things mentioned above.

AF: Does UMPO investigate a feasibility of independent modernisation of aircraft engines produced, or does it prefer introducing innovations, proposed by designers?

VL: Aircraft engine modernisation is a complicated process. Designers of a single mass-production plant will not be able to shoulder a burden like that. It requires a whole institution to do that. That is why UMPO provides maintenance and modernisation of aircraft engines jointly with the following designer enterprises: the Lyulka Scientific Technical Centre, which is part of OAO NPO Saturn (AL-31F, AL-31FP, AL-53F, and AL-55 engines), FGUP NPP Motor Scientific Production Enterprise (R25-300, 95Sh, and R195 engines), the GUP TMKB Soyuz Tushino Machine-building Design Bureau (R29B-300 and R29BS-300 engines), and the Zaporozhye-based MKB Progress Engineering Design Bureau (D-436T1 and D-436TP engines). We cooperate with the afore-mentioned enterprises on a contract basis.

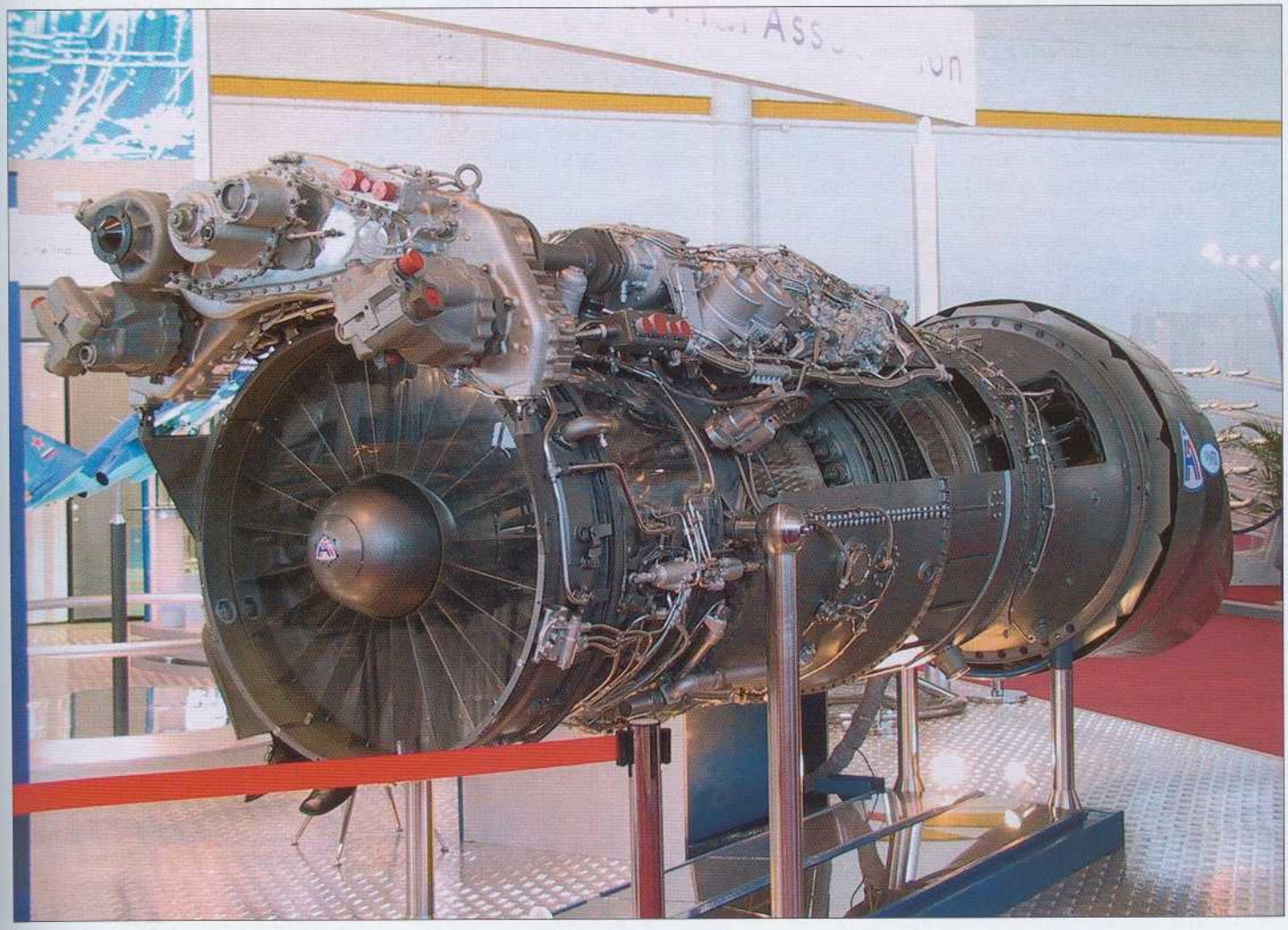
Russia, which boasts great industrial potential, especially in the defence industry, but has limited financial assets earmarked for developing and manufacturing contemporary products, should stop selling production licenses and start setting up joint ventures for developing and manufacturing future products with the largest partners.

AF: Does UMPO have any joint programmes with foreign counterparts? How does it develop its defence industrial cooperation with India? What other foreign partners does the enterprise cooperate with at the moment, and what foreign countries may become its partners in the near future?

VL: UMPO has been directly involved in the defence industrial cooperation with India for over 30 years. Within this period of time UMPO has helped the HAL Corporation successfully establish licensed production of the R25-300 engine for the MiG-21bis aircraft and the R29B-300 engine for the MiG-27.

At present UMPO is appointed flagship company for providing technical assistance in setting up licensed production of the AL-31FP power plant and its units, under the general contract on establishing licensed production of the Su-30MKI in India.

In compliance with the contract's timeframe, UMPO has worked out and shipped off the first



batch of production license documentation for the AL-31FP engine and its units, as well as documentation for production equipment. It will next deliver unique equipment, tools, and devices. The project in question secured cooperation with India for the next decade.

In addition to that UMPO has also delivered R13-300, R25-300, R29B-300, and AL-31F power plants to the Indian Air Force, both as part of aircraft delivered and a separate unit, and carried out overhauls of the afore-mentioned power plants, as well as delivered their spare parts.

Since 2002 our enterprise has been providing India with the state-of-the-art AL-31FP thrust vector control nozzle engines, mounted on the Su-30MKI. In the near future UMPO plans to start direct deliveries of the AL-31FP to the Indian Air Force.

UMPO is also providing assistance in establishing a maintenance service centre, tasked with repairs of AL-31F and AL-31FP engines. Besides materiel deliveries UMPO also ships off production forms and records, equipment and tools for providing maintenance, as well as carries out consultations and training of Indian experts.

UMPO's long-term partners in the sphere of defence industry comprise China, India, and Vietnam, while relations with Algeria are now being established. The enterprise may start cooperating with Ethiopia, Malaysia, Indonesia, and a number of other states in the near future.

AF: What is the shareholding capital structure of OAO UMPO?

VL: The state holds 35 per cent of all shares plus one 'Golden' share. The rest of the stock is shared by 64 entities and in excess of 15,000 individuals, with the former enjoying almost 59 per cent of the authorised capital stock.

AF: What is the present state of UMPO's relations with such major Russian and CIS counterparts as NPO Saturn, MMPP Salut, ZMKB Progress, and OAO Motor Sich? Does UMPO plan on expanding the list of its partners?

VL: An aircraft engine is the product of a whole range of enterprises, rather than just one company. Thus, our enterprise has had close links, based on mutually beneficial contracts, with many Russian and Ukrainian companies and organisations.

UMPO has had long-term business relations with Saturn with respect to the AL-31-family aircraft engines, as far as both design and production cooperation are concerned. We expect to team up with the company in order to develop the fifth-generation engine. The very same enterprise has launched the AL-31ST engine into mass production.

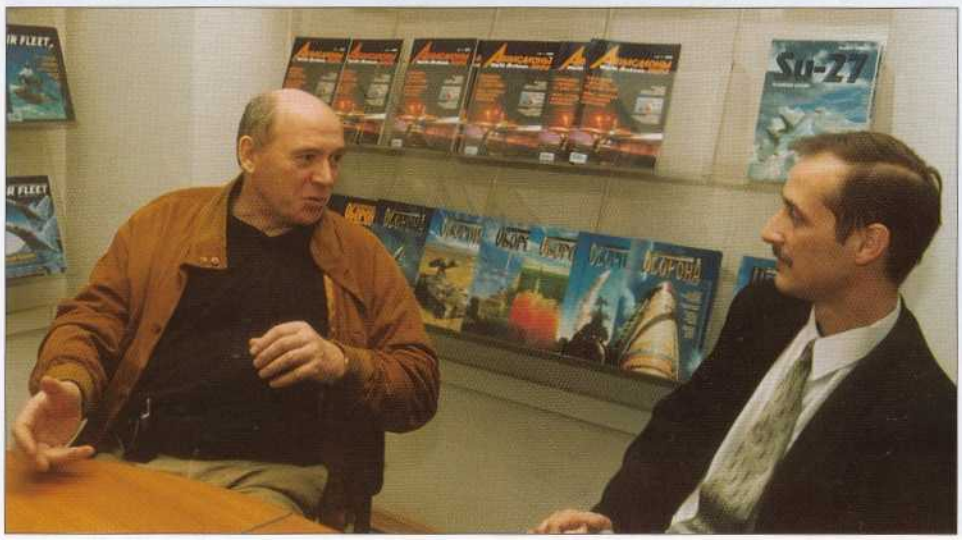
We keep on working jointly with MMPP Salut on manufacturing the AL-31F power plant. Although both enterprises enjoy a complete production cycle of the AL-31F, joining efforts is still more profitable.

As far as Ukrainian enterprises are concerned, our cooperation with them is based on Intergovernmental Agreements in the sphere of aircraft development, production, deliveries, and operation. Jointly with Salut and Motor Sich, UMPO participates in manufacturing the D436TP engine for the Be-200 amphibian and the D436T1 power plant for the Tu-334 liner. Our enterprise has joined efforts with Motor Sich to master production of six-megawatt D-336-2T gas turbine drives, designed for gas-pumping units of underground gas storage facilities.

Development of the fifth-generation power plant will require joint efforts of many enterprises, thus, the list of partners is certain to grow bigger.

AF: The Russian government plans to establish a number of holding companies, including an engine-building one. What do UMPO executive officers think about that? What do you think is the most efficient way of integrating your enterprise with other companies, operating in the same field?

VL: It is pretty clear to everyone, even without any governmental decrees or programmes, that one cannot last in the modern aircraft engine market on his own for a long time. The only problem is to choose the approach for conducting restructuring and integration. I don't think any administrative enforcement measures would work. What we need is mutual interest of all enterprises, based on common work, which is known to bring people together. However, there is no cure-all, as the process may take unexpected turns. But we do need common objectives and goals. For instance, UMPO and Salut have recently set up the joint Gas Turbine Engines Corporation in order to ensure stable sales of engines and invest in strategic development programmes. I believe we did the right thing from the strategic perspective.



HEART OF FIGHTER

A tight formation of six jet fighters is performing aerobatic manoeuvres in rapid succession... The demonstration ends with an effective champagne split. The audience's applaud drowns in powerful engine roar. Russia and Finland, Belgium and Thailand, Germany and Malaysia are familiar with the sound of RD-33 engines that power the MiG-29 jets of the Swifts aerobatic team. And pilots with many European air forces operating MiG-29 fighters highly praise these engines.

Developed by the Chernyshev Moscow Machine-Building Enterprise (Chernyshev MMP), the RD-33 engine entered production after the 1984 official tests (Chernyshev MMP still continues production of these engines). The engines powered MiG-29 fighters, the pride of Soviet military aviation; the Air Force needed hundreds of new MiGs for large-scale transition from ageing fighter types, which meant the annual demand for over 1,000 RD-33s. Chernyshev MMP coped with this task by totally reequipping its production facilities, introducing new technologies and deploying numerical control machine tools. A unique manned welding chamber introduced at that point is still regarded by foreign specialists with sheer amazement. Chernyshev MMP became one of the first Soviet enterprises to operate numerical control machine tools; today CALS technologies are widely used by the leading workshops and divisions of the enterprise.

Another fact worth mentioning is that the RD-33 production entry and associated production rearrangement in no way hampered production of R27F2M-300, R29-300 and R35 engines, which powered the previous MiG generation (MiG-23 fighters and MiG-27 fighter-bombers). And earlier still, from 1959 to 1973, Chernyshev MMP built 12,000 R11 family engines for MiG-21 fighters, Yak-28 interceptor/bombers and Su-15 interceptors. It is no exaggeration to say that virtually all Soviet fighters were at that time powered by Chernyshev MMP-built engines.

Chernyshev MMP in 1948 became one of the first Soviet enterprises to launch production of jet engines by introducing the RD-500 for installation on La-15 and Yak-23 fighters. Shortly after that the enterprise launched production of VK-1 engines for MiG-15s and MiG-17s, and later on switched to production of AM-5A turbojet engines for Yak-25 interceptors.

Chernyshev MMP is acknowledged for launching production of "Article S2.1150", a cluster of four liquid-propellant rocket engines for the Burya intercontinental cruise missile.

Nowadays, Chernyshev MMP-built engines can be found in all continents save for Australia and the Antarctic. Over 40 countries know firsthand the top quality and high reliability of these engines. But such sophisticated mechanisms as engines require service support and regular repairs. Chernyshev MMP offers its foreign partners individual operating support plans for R-29-300, R27F2M-300, R-35 and RD-33 turbojet engines. Simultaneously with scheduled overhaul these engines undergo reliability enhancement and service life extension procedures. In its capacity as industry flagship Chernyshev MMP possesses unique intellectual property and constantly perfects production technology: its cur-

Thrust vector control version of the RD-33 turbofan

rent production lines considerably differ from those operated a decade ago. State-of-the-art equipment, qualified personnel and an advanced quality management system guarantee uninterrupted operation of Chernyshev MMP-built engines. This is why engines overhauled by the manufacturer cannot be differentiated from absolutely new products.

Constant technology and design efforts to perfect the RD-33 bypass turbojet have extended its design time between overhauls and specified life; the engine is now capable of on-condition operation. RD-33 Series 2 engines have 350-700h time between overhauls and 1,200-1,400h specified life, and RD-33 Series 3 engines have 1,000h time between overhauls and 2,000h specified life.

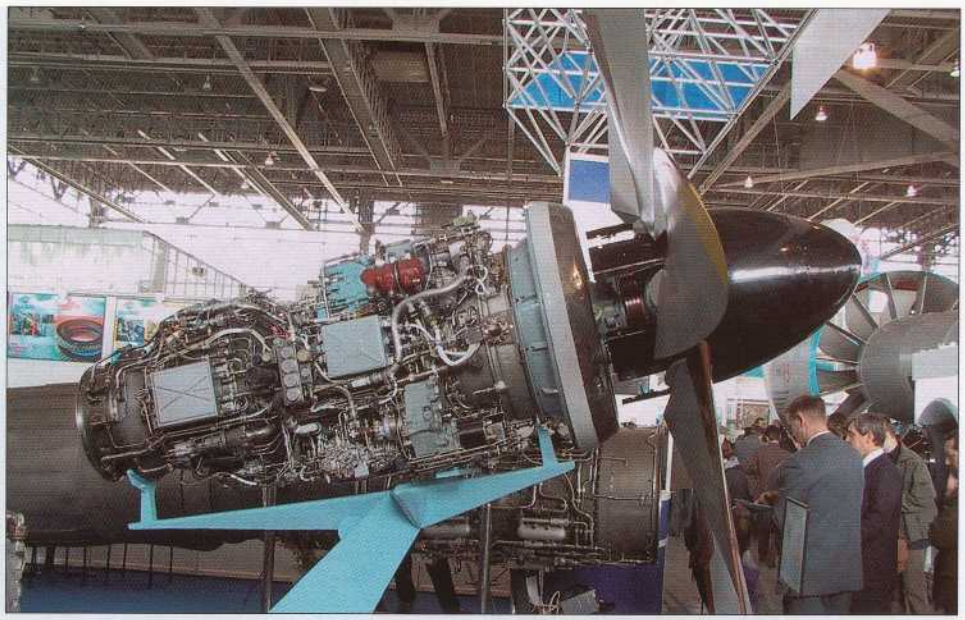
Chernyshev MMP perceives a unique engine overhaul strategy, in accordance to which engines are repaired using the equipment and technology employed in building new engines. This approach helps the enterprise bring old engines up to the contemporary level. By customer's request, Chernyshev MMP may retrofit engines being overhauled to extend their time between overhauls and specified life.

The RD-33 has unique gas-dynamic parameters, high reliability, small size and weight that enable installation of this advanced engine to second- and third-generation warplanes. One such example is the South African Air Force Mirage F1 fighter, which got the RD-33N engine with a bottom-mounted accessory box. The new engine proved so favourable for the fighter's performance that the upgraded aircraft was

Aleksander Novikov, Director General, Chernyshev Moscow Machine-Building Enterprise

renamed Super Mirage. The RD-33 is immune to external disturbances (including during application of onboard weapons), places no restrictions on flight modes and has favourable tractive effort-speed characteristics.

Chernyshev MMP is mastering lastest RD-33 modifications designed by the Klimov plant, including the RD-33MK bypass turbojet engine for MiG-29K shipborne fighters; the enterprise expects to shortly launch production of a thrust



TV-7-117S turboprop engine

vector control version, the first Russian engine whose nozzle will be able to deflect in all directions. This feature will give the MiG-29OVT fighter gas-dynamic pitch, yaw and roll control.

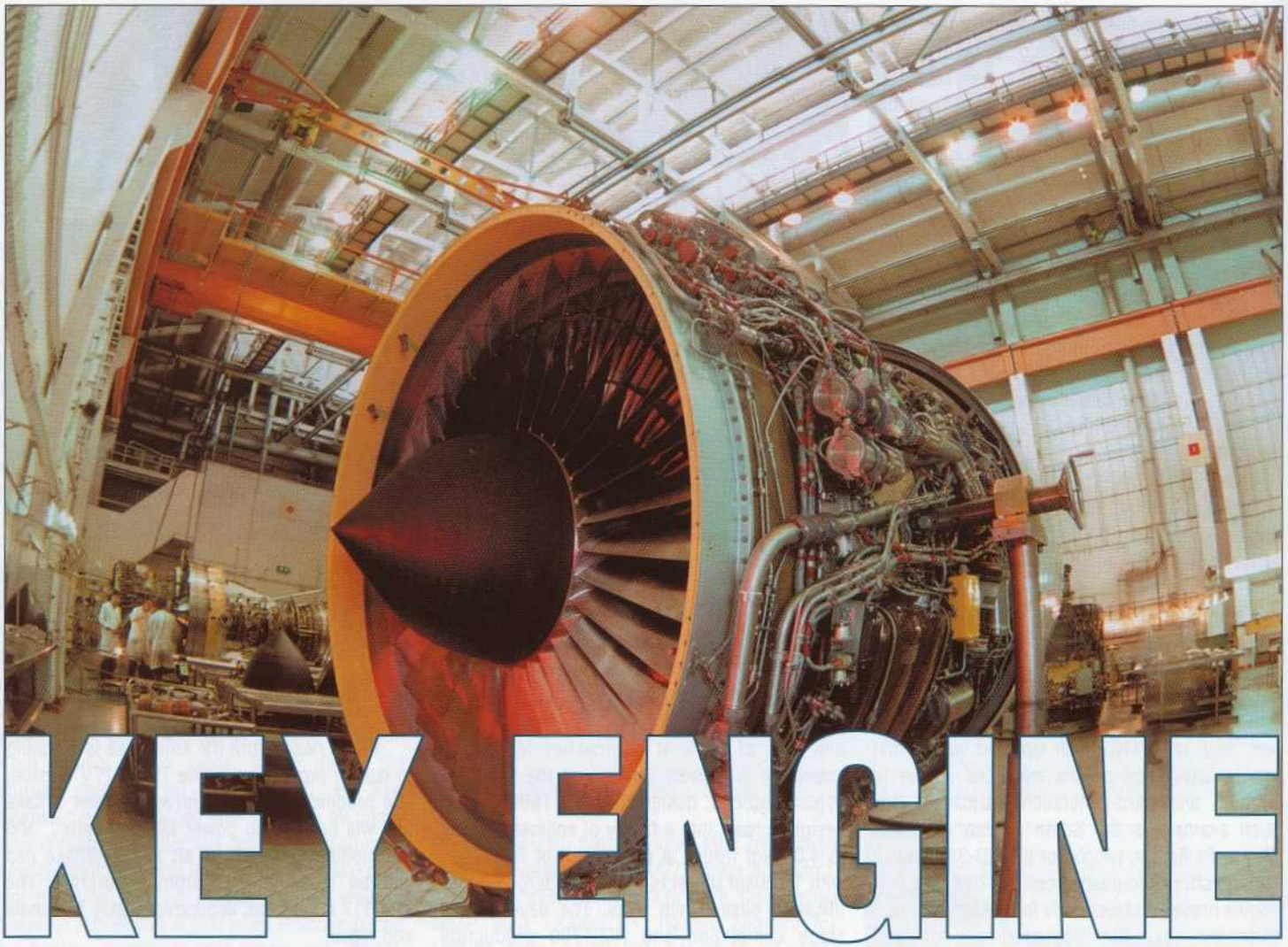
Improvement of the RD-33 engine is not the only line of work at Chernyshev MMP. The enterprise is actively developing the RD-1700 bypass turbojet, designed at the TMKB Soyuz design bureau, into a family of engines with up to 4,000kgf thrust. A pilot batch of RD-1700s with 1,700kgf thrust is already undergoing certification base bench tests. The development stage completion and RD-1700 production launch are scheduled for 2004. The RD-2500 with 2,500kgf thrust should be prepared for official tests in the fourth quarter of 2005. The 2003 state defence order envisions continuation of work on the RD-1700 and RD-2500 engines.

Chernyshev MMP has launched production of the TV7-117S free-turbine turboprop engine for the Il-114 aircraft. The engine has been issued a type certificate, and the enterprise has obtained a license for TV7-117S production. The engine may also be used as part of ship power plants and stationary power plants running on different fuel types.

In the near future the enterprise is planning to launch production of the TV-7-117V version. The modification with a forward power offtake pad will be used to power Mil helicopters, and the modification with an aft power offtake pad will be installed on Kamov rotorcraft. The TV7-117 is efficient, economical, easy to handle and repair.

Over its 70-year history Chernyshev MMP has made a long way from a small wooden workshop to a renowned leader of Russia's aircraft industry. This stable enterprise keeps pace with advances in science and technology, and bases its policy on experience and professionalism boosted by hi-tech equipment, powerful testing facilities and progressive quality control methods.

RD-1700 prospective turbofan engine for advanced combat trainers



KEY ENGINE OF RUSSIAN AVIATION

Yury Reshetnikov,
Director General, Perm Engine Company,
State Prize Winner

The Perm Engine Company was based on the Perm Motors JSC in October 1997. Having progressed through hardships of the development period, the company is confidently gaining steam. Since 1998 its sales have been increasing 1.5-fold each year, while in 2002 the figure in question increased 1.8-fold. In light of growing contract portfolio the plant has re-established 2,000 vacancies, cut down by Perm Motors during the economic recession, and has undertaken the employee professional training programme. Only last year every fourth employee of the Perm Engine Company underwent an advanced training programme. Due attention is also paid to reconstructing production sites, and upgrading equipment and technologies by earmarking considerable funds to this end.

Such a high growth of output and sales is accounted for by the fact that products, manufactured by the company, are in great demand, given the mushrooming Russian economy. Main products of the Perm Engine Company, comprising the PS-90A power plant and five types of industrial gas turbines, made a winner at the annual Top 100 Russian Goods contest in 2000, 2001, and 2002. However, the most important thing is that the products in question are enjoying a yet increasing demand with major national customers, namely Russian air carriers, and Gazprom, as well as many other enterprises, operating in the sphere of oil and gas production and power engineering.

The PS-90A aircraft power plant provides the Il-96-300, the Tu-204, and the Tu-214 airliners with a high fuel-consumption efficiency and low levels of noise and emissions, which makes the aforementioned aircraft an appealing option for air carriers. The company employees are proud to have manufactured and delivered the given power plant for the Il-96-300PU, a second presidential airliner. Two Tu-204-100S transports, also powered by the engine in question, have actively been operated in Europe by the TNT company. Within a three-year period of constant flights (most of them carried out at night) there has only been one delay so far.

The Perm Engine Company would not have been able to achieve such outstanding results without cooperation with its partners.

The Aviadvigatel JSC, headed by Director General/Designer General A.A. Inozemtsev, is the

main long-term partner of the Perm Engine Company. Aviadvigatel is the designer of both the PS-90A power plant and all gas turbines, manufactured by the plant.

Pratt & Whitney, which is a large shareholder of Perm Engine Company stocks, has actively and consistently been having a hand in the development of the plant. Pratt & Whitney has granted credits and earmarked assets for a total of over US $35 million for reconstructing and developing the Perm Engine Company. However, cooperation of the US company is not limited to financial assistance only. It also takes part in solving all crucial problems, concerning Perm Engine Company development: improving the quality control system, streamlining plant management, reducing production costs, and improving planning and marketing techniques. In addition to that Pratt & Whitney regularly awards contracts to the plant for manufacturing various parts for its engines.

The outset of re-engining Il-76 transports, carried out by Voronezh- and Tashkent-based enterprises, is another important event for the Perm Engine Company. Perm Engine Company has already embarked on producing and delivering PS-90A-76 power plants to the enterprises in question. The Il-76MF, the Il-76TD-90, and the Il-76MD-90 aircraft, powered by PS-90A-76 engines, will be capable of meeting noise-abatement requirements and considerably improving their flight characteristics, which will extend the Il-76's service life by another 15 to 20 years. The programme of aircraft re-engining, supported by the Russian government, will require at least 100 engines in the next three to four years only, thus, this project is very profitable and important for Perm Engine Company.

The PS-90A engine, manufactured by the Perm Engine Company, which is more in demand with every coming year, is really evolving into the main power plant of the Russian aviation.

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AT THE FOREFRONT OF PROGRESS

On 2 June the first production Yak-130 combat trainer rolled off the assembly line of the Nizhniy Novgorod-based Sokol plant. The aircraft is likely to succeed Czech L-39 Albatross trainers in manoeuvre units in the near future. The Yak-130 and the L-39 are aircraft of different generations, and even have different external appearance, but they still have one common feature: both the L-39 and the Yak-130 are powered by engines, developed by the Zaporozhye-based Ivchenko-Progress Machine-Building Design Bureau (ZMKB).

In spring 2003 the first two AI-222-25 engines for the Yak-130 were handed over to MMPP Salut, appointed flagship Russian enterprise, producing the AI-222. This year Russia will be supplied with eight AI-222 power plants, including six engines for the first three Yak-130 prototypes and two reserve ones.

The Zaporozhye-based plant has been developing jet engines for training aircraft for 35 years. The AI-25TL power plant for the Czech L-39 trainer was designed in 1969 basing on the production AI-25 turbofan, mounted on Yak-40 passenger airliners, and the AI-25T turbofan, designed for the T-8 attack aircraft (future Su-25) that was being developed back then. In 1973 the AI-25TL engine progressed through official tests and was launched into production at the Motor Sich JSC. Within 30 years the Zaporozhye-based plant has manufactured about 5,000 power plants like that, the total flying time of which equals in excess of six million hours. Nowadays the AI-25TL engine is successfully operated in 37 countries across the world. It is mounted on almost 3,000 L-39 aircraft, produced by the Czech AERO Vodochody.

The Ivchenko-Progress Design Bureau used the AI-25TL as a basis for developing the 2,200kgf DV-2 engine, ordered by Czech aircraft manufacturers for the L-59 trainer, a new modification of the L-39. The DV-2 power plant had been designed by the late 1980s and handed over to the Povazske Strojarne plant (Slovakia) for mass production. Ivchenko-Progress jointly with the St.Petersburg-based Klimov Plant modified the engine in question to be fitted on the Yak-130D prototype, which made its maiden flight on 25 April 1996.

Now the AI-222-25 power plant, designed by Ivchenko-Progress, will be mounted on mass-produced Yak-130 combat trainers. Outstanding performance of the AI-222-25 coupled with next-to-perfect aerodynamics of the Yak-130 will provide the aircraft with manoeuvrability at subsonic speeds comparable to that of fourth- and fifth-generation fighters.

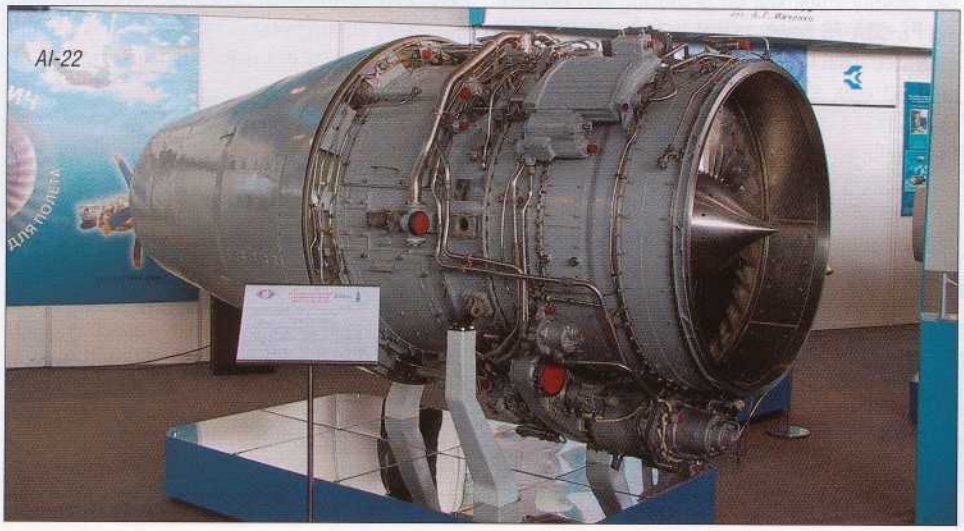
The first batch of the baseline 2,500kgf AI-222-25 engine was launched into production in 2002. The power plant will be mass produced jointly by Motor Sich (Ukraine) and MMPP Salut (Russia). The first baseline AI-222-25 engine was started on a test bed of Ivchenko-Progress in late 2002.

The most important requirements facing AI-222 family engines were maximum flight safety and high combat efficiency of aircraft they were mounted on. The turbofan design guarantees a long service life with low maintenance costs.

The AI-222 family power plants may also be fitted on a number of other Russian and foreign aircraft, both newly developed and modernised. They include the Czech L-59 and L-159, the Chinese K-8J, the Indian HJT-36, the Yugoslav G4 Super Galeb, the Romanian IAR-99 and IAR-109, the Italian MB-339, the Spanish CASA-101, the Franco-British Jaguar, etc.

In order to fill the needs of various customers in contemporary reliable and efficient turbofans with a thrust of 2,500kgf to 5,000kgf, based on the baseline AI-222-25 turbofan, Progress is currently developing a whole range of various modifications:

- AI-222-25F – an afterburner modification of the AI-222-25 turbofan with a takeoff thrust of 4,200kgf (with an afterburning degree of 1.68), designed to be fitted on trainers, combat trainers, and light combat aircraft with a maximum flight speed of M1.5;



AI-22

- AI-222-25KFK – a modification with the so-called short afterburner (a maximum length of 0.5m) with a takeoff thrust of 3,000kgf (an afterburning degree of 1.2), designed to be fitted on aircraft, which employ just one afterburning mode on a limited basis;

- AI-222-28 – a version without afterburner, which features higher specifications of the thermodynamic cycle, which in turn increase the takeoff thrust up to 2,800kgf (up to 3,000kgf in the future);

- AI-222-28F – a future turbofan modification with a takeoff thrust of 4,500kgf to 5,000kgf.

In order to increase manoeuvrability and takeoff and landing characteristics of the aircraft, all AI-222 family engines may be equipped with the thrust vector deflection system, providing for the all-around deflection of the jet wash to an angle of up to 20 degrees from the engine axis. The moving part of the nozzle is operated with the help of hydraulic cylinders on commands, transmitted by the aircraft control system.

The AI-222 family turbofans are based on the gas generator of the AI-22 turbofan. Employing the proven gas generator allowed designers to considerably reduce the AI-222 development timeframe and submit it for bench tests as early as 2001. As compared to the AI-22 the new engine boasts only such new components as fan modules, low-pressure turbines, the gear box, and the nozzle.

The AI-22 features a two-shaft design and consists of the following units:

- the low-pressure compressor (a fan and five supporting stages);
- the intermediate casing;
- the gear box;
- the seven-stage high-pressure compressor;
- combustion chambers;
- the single-stage high-pressure turbine;
- the three-stage low-pressure turbine;
- the reverser;
- the exhaust mixer;
- the jet nozzle.

The modular structure of the power plant enables it to be repaired directly in manoeuvre units. Materials and special coatings allow the engine to operate in various weather conditions.

The automatic control system (ACS), fitted on the AI-22, automatically controls parameters and mechanical aids of the engine, as well as monitors ongoing operation of the power plant, providing critical condition warning. The power plant automatic control system is an electronic one, fitted with an auxiliary hydraulic fuel consumption control loop. The electronic ACS features two equivalent control loops: the main one and the auxiliary one. If both the main and the auxiliary fuel consumption control loops fail, or the power of the ACS electronic unit is cut off, the system automatically switches to the reserve hydro-mechanical control loop.

During the AI-22 development much attention was paid to providing the power plant with high environmental performance, first and foremost, insofar emissions and noise level were concerned. The AI-22 combustion chamber design facilitates specific emissions and emission, which are even lower than those specified by ICAO standards. The power plant comprises design solutions, which reduce noise level of the fan (the primary noise source) and other units. Given the noise abatement measures taken, an aircraft, powered by two AI-22 engines, is sure to meet ICAO and AP-36 noise-abatement requirements.

AI-222-25

Efficient and safe operation of the AI-22 is provided by its high controllability. With this end in view the AI-22 is fitted with 19 current parameter sensors and 16 indicators; it also features a feasibility of inspecting parts of the gas-air path through special inspection holes and taking oil samples in order to examine wear products.

Production forms and records for the AI-22 engine were developed and the power plant proper was launched into production in 1997-98. After that eight engines were manufactured to undergo tests and refinement. The first AI-22 gas generator was started on a test bed on 28 April 1999, while as early as 26 September 2000 the first full-scale power plant of this type was assembled and tested. The year 2000 saw production of seven AI-22 engines for flight tests. The AI-22 power plant is expected to be fitted in the near future on the Tu-324 prototype being built by the Kazan Aircraft Production Association (KAPO). It is also expected to be submitted for flight and certification tests.

The Ivchenko-Progress Machine-Building Design Bureau is the world's flagship aircraft engine-building company, which has vast experience in aircraft engine development. It has actively been developing industrial gas turbines for over 35 years: for gas-pumping systems, electric power stations, drilling rigs, as well as maritime and river vessels. Power plants, designed by Progress, are widely popular due to their high reliability, efficiency, and easy maintenance. Quality, reliability, and the right to repair aircraft engines have been certified by the Veritas Bureau, ARMAK, and the Ukrainian ARGDAT.

Outstanding production and research and development capabilities of ZMKB Progress allow it to manufacture and test power plants with a thrust of up to 40t. The enterprise boasts state-of-the-art technologies, while comprehensive computerisation of the enterprise provides it with a high output.

Basic specifications of the AI-22 and the AI-222-25 turbofan engines

	AI-22	AI-222-25
Thrust, kgf:		
maximum mode (H=0, M=0)	3,755 (4,200)*	2,500
cruise mode (H=10-12km, M=0.6-0.75)	775	300
Specific fuel consumption, kg/(kgf•h):		
maximum mode (H=0, M=0)	...	0.64
cruise mode (H=10-12km, M=0.6-0.75)	0.63	0.875
Air consumption, kg/s	125.3	50.3
Pressure increase ratio	15.87	15.6
Bypass ratio	4.77	1.19
Maximum gas temperature before the turbine, K	1,455	1,455
Fan diameter, mm	1,020	630
Engine length, mm	3,062	1,960
Dry weight, kg	765	440

* Critical mode

QUALITY AND RELIABILITY

NEW DEVELOPMENTS CONTINUING OLD TRADITIONS

Vyacheslav Boguslayev,
Chairman of the Board,
Director General,
Motor Sich Joint Stock Company

The Motor Sich JSC is one of the world's oldest and largest enterprises, which boasts the complete production cycle of contemporary aircraft engines starting from their production and tests up to providing product support and conducting repairs.

Most engines manufactured by Motor Sich have become leaders across the globe in their respective class: the AI-25TL turbofan is mounted on over 3,000 trainers and combat trainers in service with 38 countries in all corners of the compass; the TV3-117 helicopter engine powers almost all Russian-produced medium helicopters in the inventory of 60 foreign states; the D-18T engine is designed to be fitted on the Ruslan and the Mriya aircraft, the world's heaviest transports; the most powerful D-136 helicopter engine, etc.

The quality and reliability of products manufactured are proved by years of successful operation in 109 states on 61 types of fixed- and rotary-wing aircraft, designed by such worldwide famous companies as Antonov, Ilyushin, Beriev, Tupolev, Yakovlev, Kamov, Mil, the Czech Aero Vodochody, and the Chinese NAMC.

The enterprise tries to secure its niche in the international market by adhering to the whole scope of marketing techniques, including, first and foremost, participation in various air shows, which demonstrate recent achievements, promote new technologies, broker fruitful meetings, and facilitate short cuts to various markets.

That is why, at present Motor Sich is having a hand in the Paris Air Show, which is one of the world's major air shows.

This year the enterprise is exhibiting a future AI-22 engine. This turbofan is another modification in a long line of such high-bypass-ratio turbofans as the D-36, D-436T1/TP, and D-18T, all of them manufactured by the enterprise.

The baseline version of this engine boasts a takeoff thrust of 3,820kgf and an emergency rating thrust of 4,200kgf. The turbofan is designed to be mounted on the 46-seat Tu-324 passenger airliner, which is to succeed the obsolete Yak-40 and An-24, as well as the VIP version of the aircraft in question.

If necessary, more powerful modifications of this engine, featuring a thrust of up to 4,500kgf, may be developed in the future.

Motor Sich has developed the AI-222-25 engine, based on the future AI-22 gas generator, launched into production at the enterprise. This engine is a new-generation power plant designed by Motor Sich for trainers, combat trainers, and light combat aircraft.

The AI-222-25 engine has a maximum thrust of 2,500kgf and is designed to be fitted on the Yak-130 combat trainer, developed by the Yakovlev Design Bureau, which has won the bid to be fielded with the Russian Air Force.

High performance of the power plant (comprising two AI-222-25 engines) coupled with the next-to-perfect aerodynamic configuration provide the Yak-130 with manoeuvrability characteristics at subsonic speeds, inherent in contemporary and future combat aircraft. The AI-222-25 aircraft engine will be displayed at the 2003 Paris Air Show in the exhibition hall of the Yakovlev Design Bureau as part of the Yak-130 aircraft.

The AI-25TLSh project is one of the most recent achievements in the sphere of upgrading existing and mass-produced aircraft engines.

The AI-25TLSh turbofan is yet another modification of one of the world's most popular engines, fitted on training aircraft, which has been successfully operated on Czech L-39s and Chinese K-8Js. Motor Sich has manufactured a total of over 5,000 engines like that, the overall flying time of which equals 6.5 million hours. The engine in question proved to be one of the most reliable engines of its class. The ratio of unscheduled removal throughout the service life is less than 0.1, i.e. mean time beyween removals equals at least 10,000 hours.

The AI-25TLSh engine boasts a maximum combat mode featuring a start up thrust increased from 1,720kgf to 1,850kgf, which equals a thrust of 1,720kgf at an outside temperature of +30°C. In the terrain-hugging mode at a speed of M=0.6 and an outside temperature of +30°C the maximum combat mode thrust has been increased from 1,100kgf to 1,250kgf. This fact enables the engine to considerably improve flight characteristics of aircraft in the inventory of such states with hot climate as Thailand, India, Cuba, Vietnam, etc.

At the same time the upgraded engine boasts a two-fold reduced acceleration period (five to six seconds).

The AI-25TLSh engine will be displayed at the 2003 Paris Air Show as part of the L-39U aircraft, exhibited by the Ukrainian MoD Odesaviaremservis enterprise, which has upgraded the afore-mentioned aircraft.

Under the Intergovernmental agreement between Ukraine and Russia, Motor Sich has teamed up with the Moscow-based MMPP Salut

D-27 propfans on the An-70 freighter

plant to launch the world's first D-27 cruise propfan into series production. The engine, designed by the Ivchenko Progress Design Bureau, has incorporated the latest achievements of the national aircraft engine-building. With a takeoff thrust of 14,000hp, its fuel-consumption efficiency is 25 to 30 per cent higher than that of contemporary turbofans.

The engine mentioned above is designed to be mounted on the An-70 wide-body military transport, which is a direct successor of the An-12, one of the world's most popular military transports, powered by the AI-20 turboprops that are also produced by Motor Sich. The propfan provides the An-70 with a two-fold increase in its wing lift at takeoff and landing (enabling the aircraft to take off and land on short unprepared runways), as well as greater cruising speed at low noise level.

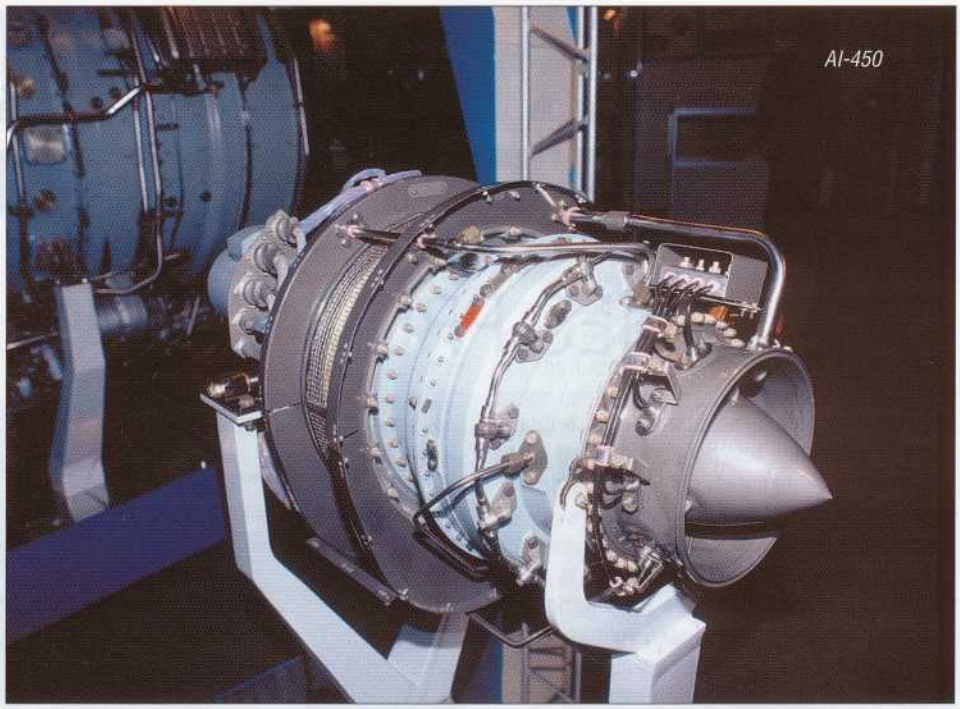
Later on the D-27 engine is expected to power various modifications of the An-70, including the air tanker, the AWACS version, and the An-70T civil transport, which is already under construction, as well as the Be-42 amphibious aircraft.

The TV3-117 family power plants also rate high on Motor Sich's production list. Various modifications of the TV3-117, designed by the Leningrad-based Design Bureau under the supervision of Designer General S.P. Izotov, have been manufactured by Motor Sich for 30 years. The enterprise has delivered in excess of 22,000 such power plants, which logged a total operational time of about 14.6 million hours on most medium

combat, utility, and civil ground- and sea-based helicopters, designed by Mil and Kamov, now in service with 60 states across the globe.

As far as its main unit specifications and gas dynamic stability are concerned, the TV3-117 is one of the world's flagship helicopter engines of its class.Motor Sich jointly with the Klimov Plant, designer of the TV3-117, has constantly been upgrading the engine and developing its modifications to be fitted on new helicopters.

For instance, the VK-1500 family engines have been based on the TV3-117 gas generator. The engines are fitted with the new electro-hydro-mechanical adjustment and control system, which optimises their operational performance and registers operating time. The engine design incorporates design solutions, which provide for low noise and emission levels.


AI-450

At the present time the VK-1500S modification is undergoing bench tests. This version is adapted to be fitted on An-2s, manufactured earlier, while upgrading them to the An-3 standard. The new power plant will provide this local airline old-timer with a second wind by facilitating better flight characteristics and providing its passengers with the contemporary comfort level.

The VK-1500VM helicopter engine modification, designed to replace obsolete TV2-117 power plants on Mi-8 helicopters, is also progressing through bench tests.

In the near future Motor Sich plans to develop a new VK-1500VK modification likely to be mounted on Ka-60s and Ka-62s.

The VK-2500 engine, which is a further improvement of the TV3-117VMA power plant, has become the latest achievement in modernisation efforts.

As compared to its predecessors the VK-2500 power plant boasts an increased power of up to 2,400hp at takeoff and up to 2,700hp in the emergency rating, which holds true at an outside temperature of up to +30°C. This allows helicopter performance to be drastically improved.

For instance, helicopters, powered by the VK-2500, will be capable of climbing 1km higher with a payload of 1-2t heavier (depending on the type of the helicopter). They will also enjoy greater capabilities, when operated in alpine terrain in hot weather, as well as higher speed and better manoeuvrability.The VK-2500 is fully interchangeable with the TV3-117 power plant, so it can be fitted on both new and existing helicopters.

Motor Sich puts a great bet on the new AI-450 helicopter engine, which has a takeoff power of 465hp and a thrust of 550hp in the emergency rating.This engine is developed jointly by the Progress Design Bureau and Motor Sich, which has already manufactured the first prototypes. At the present time the engine is successfully undergoing bench tests.

The AI-450 is designed to be mounted on the new Ka-226 helicopter, designed by the Kamov Design Bureau, which is a deep modernisation version of the Ka-26 rotary-wing aircraft that has lived up to its reputation.

Motor Sich is certain that the versatility of the Ka-226 coupled with its outstanding flight characteristics, which have considerably been boosted by AI-450 power plants, will enable the afore-mentioned helicopter to secure its befitting niche in international aviation.

Nowadays, the Zaporozhye-based aircraft engine-building plant offers the international market certified quality products, featuring high specifications. Production of up-to-date engines, as well as repairs of all power plants produced, are certified by the IAC Aviation Register and the Ukrainian Air Transport State Department.

The Motor Sich quality system has been certified by the BVQI transnational company as compliant with the ISO 9001 standard.

The well-developed and fine-tuned maintenance service system for products, delivered to customers, allows the enterprise to provide its customers with highly competitive services with respect to engine maintenance throughout their service life in almost any corner of the world.

In conclusion, it is worth mentioning that Motor Sich always welcomes new partners, interested in expanding their links in order to establish mutually beneficial and promising cooperation in the sphere of developing, manufacturing, and operating aircraft. Motor Sich's goal is to manufacture long-term and reliable products, capable of meeting all requirements of customers and providing consumers with maximum comfort.

LAUNCHING MODERN ONBOARD COMPUTERS INTO SERIES PRODUCTION

Future sophisticated multirole onboard radars define tougher requirements to be met by integrated computers generally, and onboard computers in particular.

Analysis of the challenges facing onboard computers has shown that it is a must to develop a whole range of various modifications of computers to be employed with various radars, fitted on fixed- and rotary-wing aircraft, rather than just one modification, in order to keep up with modern aircraft radars.

This objective can only be fulfilled on a short notice (defined by the market) and with a sufficiently high scientific-technical quality if development and production of prototypes followed by that of mass-produced systems are closely linked. In other words any development should be oriented towards the existing production techniques at a given enterprise, while the latter should constantly beef up its capabilities in order to manufacture contemporary products of high quality. This does not mean that development capabilities should be limited by production capabilities of the manufacturer, it only means that those production capabilities should be taken into account when new prototypes are designed. It is quite obvious that manufacturing prototypes at a mass-production plant considerably reduces the timeframe for launching new production into series production.

Given tough requirements with respect to reliability and immunity to the outside environment to be met by aircraft systems, the Ryazan State Instrument Plant defined the following three workstreams of manufacturing contemporary onboard computers:

- employment of proven production techniques for manufacturing multilayer printed circuit boards, and carrying out precise machining and automated surface mounting;
- employment of highly reliable components;
- automated quality control.

Baget-54 onboard computer

ERSASCOPE 2000 visual control system

Previous experience has shown that in order to achieve stable quality and reliability of products, the afore-mentioned technologies should be integrated into a single system, rather than be based on automating separate operations. At the same time the integrated system in question should be based on automated assembly lines with an automatic step-by-step control and a minimum interference of the human factor in the production process.

GRPZ manufactures fourth to fifth accuracy grade multilayer printed circuit boards with up to 20 layers, a minimum conductor width (gap) of up to 0.12mm, through and blind metal-plated holes, a protective coat, and various metal coatings (POS-61, Au, Pd).

When manufactured, multilayer printed circuit boards undergo constant quality control, provided by the optical control system, and a full electric parameters test control, designed to test multilayer printed circuit boards produced. The technology in question sometimes undergoes additional tests to prove that its quality is stable.

Production of polyimide multilayer printed circuit boards has recently been mastered to integrate them into systems, operating in extreme thermophysical conditions. The new multilayer printed circuit boards will have up to 12 layers, minimum conductor widths and gaps of up to 0.1mm, 200-mkm thick heat-spreading copper layers, while their faces will be metal plated, which will allow them to facilitate conductivity heat-removal.

New-generation onboard computers show a stable trend of replacing unit hulls, housing terminals on the edges, with surface-mounted hulls with matrix terminals. The latter provide both more terminals per unit of area and weight, and better mechanical, electric, and cost characteristics. Employment of BGA hulls reduces dimensions of components and in-circuit joints, which both miniaturises electric products, and increases their operational frequencies. Requirements to the accuracy of positioning a BGA hull on a printed circuit board are less stringent than those facing a QFP hull with edge-mounted terminals and small terminal steps. In addition to that light BGA hulls (save for ceramic ones) are self-aligning at installation.

Contemporary equipment provides for installing and removing microcircuits inside BGA hulls. In order to remove various parts GRPZ has introduced the TF-700 convection programmed system, designed to install and remove all kinds

of SMD components, including BGA hulls. Special attention was paid to technologies capable of facilitating reliable junctions of high quality.

According to statistics, about 60 per cent of all rejections in assembling units with SMD components at series production plants are caused by low quality of applying soldering paste through the mask. The quality of pasting is affected by a host of factors: the quality of the soldering paste proper, the structure of the printed circuit board and the mask, the temperature and humidity in the workroom. In addition to that it is a must to use masks with proven technique of calculating the size of holes for lands in order to apply the required quantity of soldering paste, as well as width. The enterprise employs the laser blank cutting system, which provides high production precision, in order to manufacture quality masks.

Fully automated machines are used to install components on plates. They are capable of mounting microcircuits with super-small steps, as well as small-size assemblies. Machines like that can feed components from any standard belts, magazines, and matrix trays in sufficient quantities; employ technical vision systems for centring components; mount components with a standard size of 0402 (1.0x0.5mm) to microcircuits with a size of 54x54, as well as QFP with a step of 0.3mm on boards with a size of 50x50 to 500x500. Adapted software reduces the time required to convert design data for series production.

Soldering printed circuit boards, mounting components, may be carried out inside convection travelling oven with the unique Multijet feeding system, easily adjusted soldering programmes, a feasibility of linking an outside computer to the system, and, first and foremost, a feasibility of operating in the nitrogen environment, thus increasing the quality of the joint soldered.

The technology of mounting various components on the SMD surface, which prevails in contemporary electronics, results in more stringent requirements facing the visual control equipment. Miniaturised components, high mounting density, small steps of terminals, and units with terminals under the hull required high magnification, high resolution, and a feasibility of controlling the process from all sides, including at an angle.

In fact, the final control of the soldering quality of BGA hulls is the most important problem in introducing them into mass produced electronic products. The fact is that component terminals are situated under the hull surface, which is inaccessible for visual control. Employment of the ERSASCOPE 2000 optical system (Fig. 2), which provides for visual control of soldered joints under the hull of the component, allowed the enterprise to solve this problem.

ERSASCOPE 2000 is a multifunctional system. First and foremost, it is worth mentioning that optical examination of soldering quality may be carried out with respect to both BGA hulls and the like, and the PLCC and QFP hulls, etc.

Protecting surface mounted joints from moisture constitutes a special problem. At the present time the existing national series production varnishes such as UR-231 and EP-9114 cannot facilitate the required maintainability of such equipment, and interfere with removal of most modern components.

GRPZ experts have tried to develop and refine the technology of producing cutting-edge moisture-resistant coatings, which would meet quality requirements, facing contemporary products, but at the same time would be easy to apply. Coatings like that include the silicone coating, based on the new high-molecular silicone block-copolymer; the fluorine-chemical protective coating; the coating which is basically low-molecular polyethylene dispersed in organic solutions, and other special coatings.

Philips surface mounting line

Tough requirements, facing contemporary computers, with respect to capacity, reliability, weight, and size resulted in thorough selection of components, used for manufacturing onboard computers.

Strict technology discipline and constant control, starting from the very first production stages, are two of the primary approaches for providing high quality of mass-produced systems. Printed circuit boards progress through frequent constant and selective control throughout the production cycle. At the same time all major parameters are checked: compatibility of the printed circuit board and the integrated circuit, quality of coatings and transient holes, etc. The quality of components is provided by the initial examination of almost all units, especially integrated circuits, and other semi-conductor devices. Constant quality control is also carried out, when printed circuit boards are installed. Equipment, inherent in surface mounting automatic lines, is widely used with this end in view.

When mounted and assembled, all products undergo a comprehensive check up, as well as a set of tests, aimed at examining their resistance to exposure to mechanical and weather factors in order to prove that their parameters meet tough operational requirements.

All types of control and inspections during the production are automated to a great extent. For instance, the control over separate modules, and the onboard computer is fully automated. The test software, used at automated workstations, allows products to undergo a comprehensive inspection, and, if necessary, a malfunction diagnosis.

Due to correct predictions of the situation in the onboard radar market and large investments into developing its production capabilities, based on contemporary technologies, over a short period of time the Ryazan State Instrument Plant managed both to master production of a number of onboard computers, developed by outside designers, such as MVK (based on the Intel architecture), and to start series production of own Baget-54 onboard computer (Fig. 3), built around the RISC processing unit with the MIPS architecture. As far as its characteristics are concerned, Baget-54 is several fold superior to its existing counterparts. The enterprise has also developed the real-time operational system and the integrated test software for the computer in question. GRPZ is currently testing and refining the new computer on test beds of the afore-mentioned radars.

G.KOLODKO, Director,
GRPZ Scientific-Technical Centre,
N.ANDREYEV, Head, Onboard computer radio department
S.KRASOVSKY, Deputy Head, Onboard computer radio department,
V.DROZHZHIN, Head, Onboard computer assembly workshop

SIMULATOR'S NOT A CURE-ALL
BUT MEANS FOR ACHIEVING FLIGHT SAFETY

The second sci-tech conference "Simulators and training: new approaches and objectives"

It is common knowledge that the lion's share of all air accidents is caused by the so-called human factor - errors, made by flight and maintenance crews, ground air-traffic controllers, and, by and large, people, who one way or another deal with aircraft either in the air or on the ground.

For instance, between 1996 and 2003 helicopters in service with the Russian Civil Aviation were involved in 113 air accidents, including 38 crashes, which resulted in 177 deaths. As many as 45 helicopters were damaged on the ground, while a total of 92 aircraft were scrapped. The notorious human factor, which accounted for 86.5 per cent of all air accidents, became the prime cause of the air accidents in question, while aircraft malfunctions in the air accounted for only 10.5 per cent.

Why does a human being remain the 'weakest chain link' in the human-to-machine, or pilot-to-aircraft cooperation? The matter is that contemporary aircraft feature supersonic speeds, awesome ranges and altitudes, a great number of avionics, mounted in the aircraft cockpit, automatic flight control systems, and radars, which results in an avalanche of information, which makes pilot constantly solve sophisticated logical problems, inherent in handling an aircraft, and operation of the power plant and other equipment.

Lack of time, caused by higher speeds and altitudes, sophisticated aircraft, and rapidly-changing environment, which presses for immediate actions, as well as dramatic physical and psychological stress resulted in the fact that nowadays pilots suffer much higher physical and psychological stress, and earlier fatigue as compared to those of the most recent past.

The completion of the mission and the flight safety considerably depend on the pilot's experience, and his ability to act decisively and take correct decisions under stress. That is why much attention is paid to developing such crucial qualities no pilot can do without as inner recollection, an ability to focus on the priority, psychological stability, self-control, self-possession, and, first and foremost, fast and spot-on reaction to aircraft failures in the air.

Special ground simulators have been designed specifically with this end in view. They help unearth any inaccuracies in piloting techniques, polish up the skill of splitting one's attention between piloting an aircraft, and controlling its systems and power plant. Besides they reduce one of the primary adverse factors, causing air accidents, namely the unexpected nature of emergency situations.

Training on these flight simulators allows a pilot to believe in his abilities and capabilities of his aircraft, as well as to psychologically prepare for possible emergencies in a real flight.

All the afore-mentioned issues were discussed at the second sci-tech conference "Simulators and training: new approaches and objectives", held in Zhukovsky outside Moscow.

The statement that aircraft simulators are the primary ground means for training air crews and maintaining their professional skills, which considerably increases flight safety, threaded all the reports, delivered at the conference.

Employing simulators for training flight personnel saves much fuel and husbands aircraft service lives. For instance, it costs about RR60,000 (roughly $2,000) to fly a Tu-154 for an hour, while an hour on a simulator costs only RR900 (about $30).

At the present time Civil Aviation training centres operate 112 simulators, including 96 integrated aircraft simulators and 16 integrated helicopter simulators. Some 35 per cent of all integrated aircraft simulators are fitted with moving cockpits, while only eight of them boast six degrees of freedom. Simulators of the following aircraft, which are still in service, are operated in training centres: Tu-134A, Tu-154B(M), Tu-204-100, Il-18, Il-62M, Il-76TD, Il-86, Il-96-300, Yak-18T, Yak-40, Yak-42, An-2, An-12, An-24, An-26B, Mi-2, Mi-8T, and A310.

However, there are no simulators for training air crews to fly such aircraft as Il-114, An-124-100, Tu-204-120, Tu-214, and An-38, as well as the Mi-8AMT helicopter. Mi-26T helicopter simulators, which have been manufactured and delivered by the aircraft industry, have not been fielded yet.

At the same time it is worth mentioning that most simulators were developed and manufactured in the 1970s-80s, and thus, they expired most of their service lives, are fitted with obsolete display systems and computers, and considerably differ from cockpits of more recent aircraft.

Given the fact that the lion's share of air traffic will be carried out by the existing aircraft fleet in the near future, it is a must to upgrade simulators as well.

As far as the military aviation is concerned, the issue of employing aircraft simulators is just as pressing. Nevertheless, new aircraft simulators are also being developed. According to Andrey Byushgens, at the moment the MiG-29 integrated aircraft simulator, designed for a foreign customer, has undergone official tests, and it is recommended that it should be fielded as a simulator for instructing flight personnel in the skills necessary for piloting the MiG-29B aircraft and engaging all its weapon systems in harm's

way. The simulator in question has been developed by the TsAGI Central Aero-Hydrodynamic Institute jointly with the Russian MiG corporation, the Dinamika Central Scientific-Technical Institute, and GosNIIAS.

According to the speaker, when developing the simulator, designers focused their efforts on creating a system capable of simulating aircraft dynamics and pilot's actions in combat environment as true-to-life as possible. The simulator cockpit is a full-size copy of the real aircraft cockpit. Simulators of various devices, control panels, and control levers allow the pilot to master and refine skills of operating cockpit equipment, which is a crucial factor given the time limit for taking decisions on the battlefield.

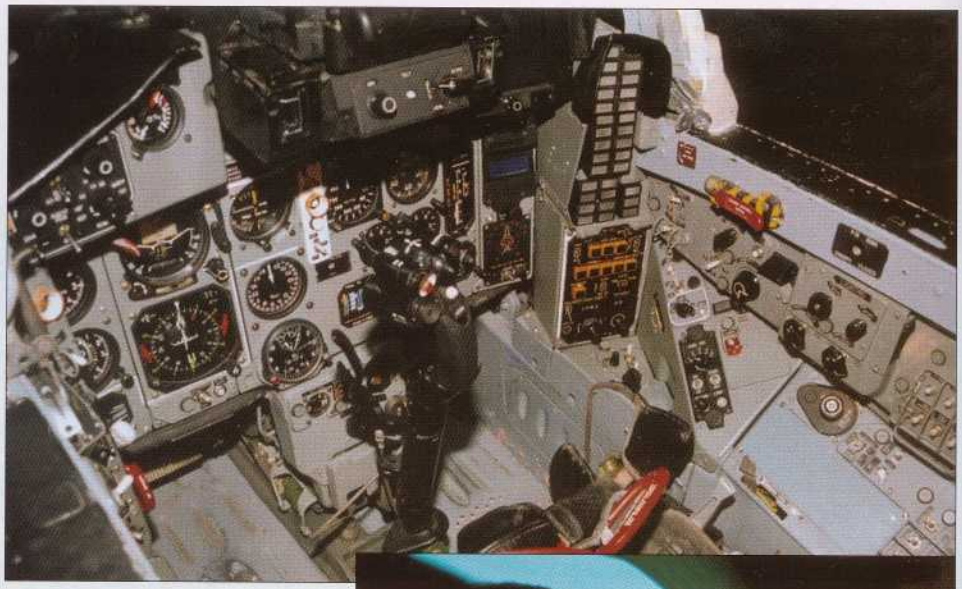
Experts have designed and manufactured a unique hydraulic system simulator, which allowed them to employ the real SOS-3 stall limitation system, which is the most important system for providing flight safety in stalling conditions.

The environment display simulator is basically a cylindrical display, which gives a 400x400-km image of real terrain, generated by high-speed computers with great resolution. At the same time the pilot sees all air- and ground-based mobile and stationary targets detected, crucial for fulfilling the mission.

Special attention has been paid to simulating the weapons control system. Given a relatively small distance from the pilot to the display (about 3.5m), the head-up display is simulated by a corresponding graphical image in the central display.

The helmet-mounted target designation system simulates the real system almost to the letter. When mastering various combat modes, the pilot can visually observe effects, caused by all weapon systems carried by the aircraft. Simulator software allows it to simulate all flight modes, envisioned by the onboard radar, at all flight stages by day and night.

In order to carry out training in pairs, there is an auxiliary simulator, fitted with the environment display simulator and control panel displays, as well as joysticks, acting as control sticks.



The new Mi-24P combat helicopter integrated simulator also generated considerable interest. According to Mr. Byushgens, the task of providing joint combat training both to the pilot and the operator was one of the new objectives, facing developers of this simulator. Unlike existing helicopter simulators, which boast only the pilot's cockpit, the simulator, being developed, is fitted with two cockpits (that of the pilot and the operator), integrated into a layout similar to that of the real helicopter. This fact allows the pilot and the operator to master combat employment skills and cooperation with each other to a greater extent. This feature is the unique peculiarity of the simulator that has been designed for a crew (pilot + operator). At present there are no other helicopter crew simulators, whereas fine-tuning joint crew actions in combat environment is of paramount importance to training flight personnel.

Various combat modes are simulated due to the precise mathematical models of helicopter dynamics, the sight, missile dynamics, as well as the weapons control system.

The operator's workstation is fitted with the sight, designed to home a missile in on a ground target. The sight comprises a fragment of a real optical part, reflecting mirrors, and an LCD. The operator controls the line of sight with the help of a special manipulator. The LCD shows a computer-generated image of outside environment (terrain, missile target) and the cross-hairs, the operator sees in the sight eyepiece with a 3.3- or a 10-fold magnification. This system, comprising a common display system, represented by a cylindrical display and the head-up display simulator that displays the cross-hairs, enables the air crew to cooperate in combat environment.

It is certainly hard to underestimate the importance of simulators in studying aircraft failures, emergency situations, and human behaviour under stress, though, on the other hand, a ground aircraft simulator is neither a cure-all nor a divining-rod, capable of getting rid of all unexpected air accidents just like that. However, befitting and timely employment of simulators for training young pilots and maintaining skills of seasoned ones, when simulating emergency situations in the air, is one of the most important ways of achieving flight safety.

Valery AGEYEV

HIGH TECHNOLOGIES 2003

The Fourth International Forum on the High Technologies of the 21st Century was held in Moscow from 21-25 April. The event showed that it can be justly considered a mouthpiece for Russian scientific and production heavyweights on a wide range of problems related to Russiaís technological and economic development. Among the participants in the forum were hundreds of Russian enterprises, scientific and research organisations, dozens of major plants of Ukraine, Belarus, and other CIS nations.

The basic concept of the forum was that of shaping and implementing the strategy of innovational development, the problem being the subject matter of the fruitful discussion held at the plenary session. A special emphasis was put on the operation of major corporations engaged in development and manufacture of knowledge-intensive products.

A decisive role of transnational corporations in national economies was highlighted by Outkin, Director of the Centre for International Studies of the US and Canada Institute under the Russian Academy of Sciences. Speaking of the companiesí importance, Outkin, among other things, forecasted that in some 15 years the volume of assets invested by transnational companies in national economies will grow by at least four times. The output of a major corporation with approximately 20,000 or 40,000 employees now equals the entire gross domestic product of a large country, for instance, that of Pakistan populated by 150 million people. In his speech Outkin also said that setting up large corporations in Russia was vitally important for the countryís economic development.

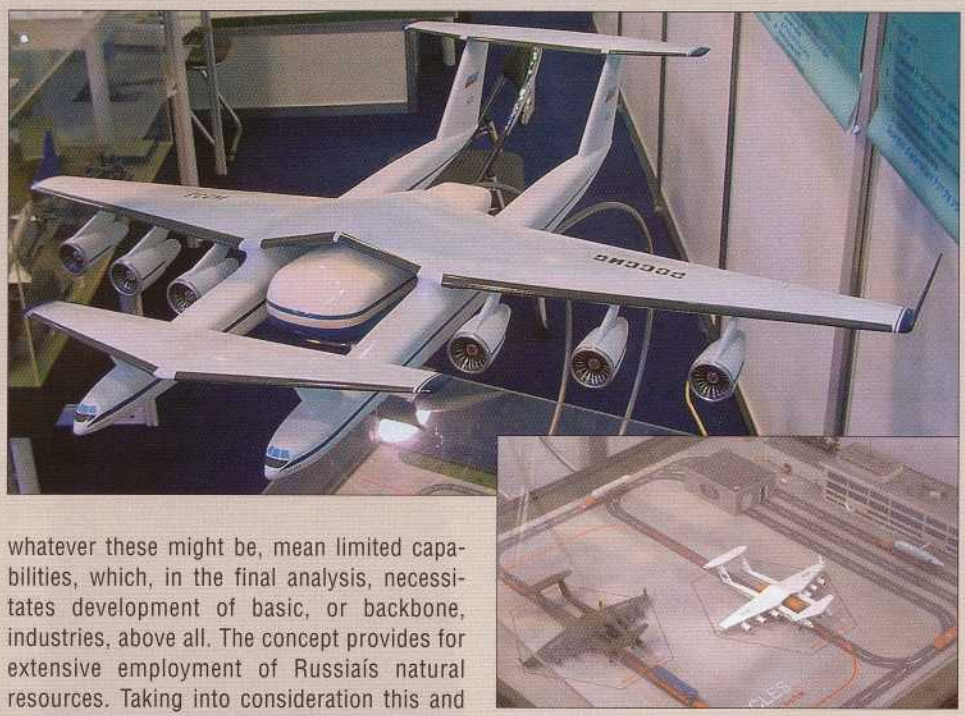
Dzhanzhgava, President of the NTsP Tekhnokomplex Scientific Production Centre, gave a talk on building a modern high-tech corporation in Russian business environment. Dzhanzhgava opined that limited resources, whatever these might be, mean limited capabilities, which, in the final analysis, necessitates development of basic, or backbone, industries, above all. The concept provides for extensive employment of Russiaís natural resources. Taking into consideration this and other factors, experts are to work out several industrial development programs, both short-term and long-term, due to slow pace of innovation and investment processes in knowledge-intensive industries. Apart from that, a general concept of Russiaís industrial policy should be designed for the purpose, too.

Development of national programs in informational industries, machine-building and biotechnological branches was the principal topic at the sub-session of the conference on Megaprojects in High-Tech Industries ñ Attracting and Using Resources.

The participants in the session were most interested in the report presented by Sirotkin, Director of the National Institute of Aircraft Technologies. The thrust of the talk was aimed at identifying best approaches to the problem of technologically re-equipping Russiaís machine-building enterprises. Special attention was paid in the course of the sub-session to building a national innovational system.

The space and aircraft complement of the exhibition held in parallel with the Forum could have been more impressive and representative. A mock-up of the MAKS vehicle, a project never implemented, and that of Buran, long in oblivion, domineered the display area.

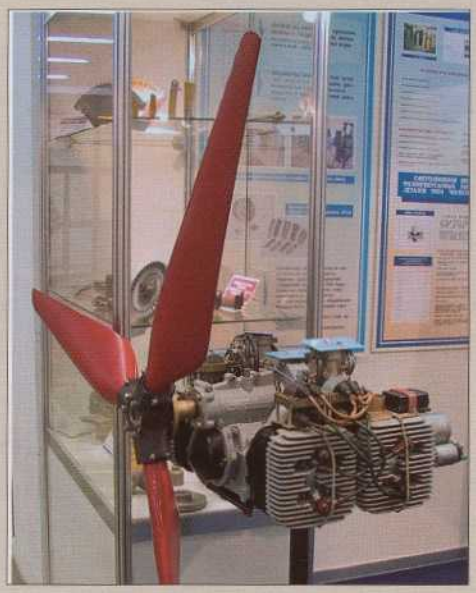
The NPO Molniya Scientific and Production Enterprise represented, for an umpteenth time, a project of the Heracles transportation aircraft. The huge double-beam plane can be based on off-class and 1st Class airfields; in the latter case the airlifter cannot be employed unless the taxiways are not adjusted specifically for the purpose. It is worth noting that the concept of developing an aircraft of the type holds high promise. Carrying modules suspended between the fuselages of the plane enable efficient transportation of non-standard and large-dimension cargoes. Short loading and unloading operations make up another advantage. To perform these, the cargo modules are to be rearranged. The passenger module accommodated under Heraclesí center-body seats up to 1,200 people. Employment of the airlifter as a complement of an air and space system, its take-off mounting to 900t, is being considered among other options, too. Platforms of the type can put into near-earth orbits up to 14t of cargo as an orbital plane or from up to nine (to a geostationary orbit) to 28t of cargoes (to a lower orbit) as an expendable launching vehicle.



Models of the Heracles aircraft

Designers of the aircraft believe that use of carrying capacities of the triplaneís surfaces coupled with the cargoís accommodation on an

The exhibition offered a glimpse of the future S-XXI space aircraft



The M-29 (P-1000) four-cylinder opposed air-cooled reciprocating engine

external platform results in lesser load on the airlifterís airframe and considerable decrease in the planeís weight and dimensions, the index mounting up to some 20%. This, in its turn, means lower cost of the aircraft in comparison with conventional configurations. Having similar dimensions, Hercules is capable of airlifting cargoes by some 1.5 times heavier that those carried by An-225 planes.

The project of the Heracles aircraft was awarded the golden medal at the Eureka-95 World Invention and Scientific Research Exhibition held in Brussels. The problem is that the Russian plane will hardly ever be constructed.

The future of NPO Molniyaís other triplanes is just as uncertain. The current plans for the company are to develop a whole family of aircraft sharing the same aerodynamic configuration. The Molniya-1000 aircraft is also known as Heracles. Molniya-400 is a cargo/passenger version capable of carrying 250 people or up to 50 tonnes of cargo. The Molniya-300 project provides for development of an executive aeroplane to seat 6-15 passengers. Molniya-100 is to be operated as a multipurpose aircraft with a seating capacity of up to 15 people. Molniya-1 that made its maiden flight on 23 December 1992 is actually the only aircraft of the family fully operational. Still without a type certificate, the aircraft can hardly be used as a commercial item. That being said, the organisation simply does not have the resources to receive certification.

Also, the exhibition offered a glimpse of the future S-XXI space aircraft, the visitors being able to both see and fiddle with the mock-up of the vehicle. Intended to carry space tourists, the S-XXI stands a better chance of seeing the light of day. The module, weighing 3,500kg, is launched by the M-55 carrier aircraft at an altitude of 17-18km. It is capable of taking two tourists to as high as 101km, with the zero-gravity flight lasting three minutes. After that the aircraft descends for landing.

The Dubna-based Machine-building Plant presented two of its latest developments, namely the Dubna-2 light multipurpose aircraft and the AVP-1200 ground-effect amphibian. However, what the visitors actually saw was posters, not real models. The projects are sure noteworthy and useful but we are hardly talking ëhigh technologyí here. The point is that both machines feature standard configuration and use conventional materials.

The AVP-102 is able to carry 540kg of cargo in a standard mode and up to 700kg when overloaded. Reaching speeds of up to 75km/h, the transport has the ability to travel cross-country at a distance of some 450km and can be utilised all-year round. Capable of effectively negotiating half-metre obstacles (both hillocks and hollows), the AVP-102 easily moves across water areas as well as snow- and ice-covered terrain. The power plant is made up of two 34hp RMZ-640 engines, one of them driving the propeller and the other actuating the air-cushion supercharger. The engines burn the AI-92 gasoline mixed with the MS-20 oil.

The UAV section displayed Rosoboronexport's GrANT civil short-range TV reconnaissance drone and BRAT short-range TV reconnaissance unmanned aerial vehicle.

Weighing a mere three kilos, BRAT is perfectly capable of flying TV reconnaissance missions at ranges of up to 30km. Operated in the non-recoverable configuration, the BRAT-2 variant can travel up to 90km. The control system can be housed on any vehicle.

Weighing 20kg, GrANT is intended to fly observation missions at ranges of up to 70km and relay information in a real-time mode. The system is claimed to boast a stealthy design being virtually invisible and noiseless in flight. Endurance is 3-4 hours. GrANT is mounted on the UAZ-3303 transporter-launcher. The UAV is designed for drop-weight take-off and conventional landing, neither requiring any expendables. The GrANT vehicle can fly as many as 100 missions. Housed on the UAZ-3962 vehicle, the control system allows simultaneous operation of four GrANTs. Each system includes two UAVs; the equipment suite comprises three gyro-stabilised TV cameras offering different fields of view.

The Fazotron Company exhibited the Gukol-2 coherent weather/navigation radar designed to be installed in light fixed- and rotary-wing aircraft for various applications. Gukol-2 can be used for assessing meteorological conditions, including those at low altitudes, against the backdrop of underlying surface echoes.

The centre of attraction was MMPP Salyutís stand featuring the AL-31 vectoring nozzle engine, the companyís all-time winner. Just as prominent a position was occupied by Ukraineís Motor Sich JSC that displayed the AI-450 and TV-1500S engines. At the Forum, both companies were given the St.George Award, Salyut winning gold and Motor Sich silver.

Kazan's KMPO was yet another engine-building company to present its high technologies. The M-29 (P-1000) four-cylinder opposed air-cooled reciprocating engine, meant for light aircraft, amphibians and speedboats, was the companyís only full-scale exhibit. The NK-93 prop-fan to power Tu-204, Tu-214, Tu-330 and Il-96 aircraft is likely to become one of KMPOís most promising developments. In terms of noise and emission levels, the NK-93 outperforms western-designed PW2337 and RB.2110535E4 engines.

Pavel IVANOV,
Andrei YURGENSON

The UAV section displayed Rosoboronexport's BRAT short-range TV reconnaissance unmanned aerial vehicle

TsSKB-PROGRESS

ROCKET & SPACECRAFT CENTRE

Pre-launch processing of the Soyuz LV at Plesetsk range

The TsSKB-Progress State Research and Production Rocket and Spacecraft Centre based at Samara was founded following the Decree of the Russian President dated 12 April 1996 as a merger of the Central Special Design Bureau (TsSKB) and the Progress factory.

The centre is a leading Russian enterprise in development of medium-class launch vehicles (LV) and Earth remote sensing systems.

The history of the Progress factory started as far back as 1894. In 1958, the large aircraft builder, as it had been, was reorganised to make a rocket and spacecraft enterprise.

In its turn, TsSKB started in 1959, when the OKB-1 (Korolev Design Bureau) design department was formed on Progress' premises to allow mastering and design support of the R7 intercontinental ballistic missile (ICBM) production at the factory.

17 February 1959 witnessed the first launch of the Samara-made missile from the Baikonur test site.

The OKB-1 design department, led by Korolev, developed the three-stage Vostok and the four-stage Molniya LVs. Both the vehicles were derived from the two-stage R7(R7A) ICBM.

At that phase of the programme Progress and Samara-based affiliate of OKB-1 (that later made up the TsSKB-Progress Centre) ensured production of two stages for Vostok and Molniya.

On 12 April 1964 Vostok took the world's first cosmonaut Yuri Gagarin to the Earth orbit, the first two stages of the LV assembled in Samara.

Since 1964 all the work on sophistication of LV design, fine tuning, flight testing and maintenance of the vehicles was entrusted to the OKB-1 affiliate as a head design office, and in 1974 it became an independent enterprise now known as TsSKB.

For over 40 years specialists of TsSKB-Progress have developed seven modifications of LVs and 26 other spacecraft featuring state-of-the-art theoretical and technological achievements.

The centre is rightfully proud of the R-7 family of LVs that boast the absolute record in terms of the number of launches (over 1,600) and high reliability ratio (0.982). The most prominent of the family is the Soyuz rocket, which is the only one entitled with the most vital mission of carrying human beings. It was used for all manned programmes. Apart from piloted missions, it also takes cargoes to the International Space Station.

Presently there are the following LVs developed and assembled by TsSKB-Progress in use:

- four-stage Molniya-M;
- three-stage Soyuz-U;
- three-stage Soyuz-FG.

Molniya was employed to launch spacecraft to the Moon, the Venus and the Mars. Molniya-M's primary objective nowadays is to orbit Molniya-type communications satellites and Kosmos-series spacecraft.

Soyuz-U has been in service since 1973. It is used to launch manned Soyuz spacecraft, Progress cargo rockets, and automatic spacecraft of various purposes, including Kosmos, Resurs, Foton and Bion series. Soyuz-U LVs, fitted with the Ikar booster, made by the centre, were involved into launches of 24 US Globalstar telecommunications satellites in 1999, and in 2000 they orbited European Cluster-2 research satellites.

The modified Soyuz-FG LV is a dedicated derivative intended to orbit the increased-weight manned and cargo Souyz-TM and Progress-M spacecraft to the ISS, the LV having already undergone a number of successful launches. The LV is propelled by upgraded first and second stage engines with increased specific thrust, owing to which payload orbited has grown by 250-300kg as compared to that of Soyuz-U.

Work is currently underway at the centre to develop a standard medium-class Soyuz-2 LV to replace Soyuz and Molniya. It is expected to be more powerful and capable of orbiting a larger range of cargoes. The resulting load-carrying capacity will grow by 1,100-1,200kg.

The Russo-French Starsem joint-stock company offers international customers orbiting payloads by means of Soyuz LVs. The company was founded in 1996 by Russian Rosaviakosmos and TsSKB-Progress, EADS and French ARIANESPASE.

The aforementioned Globalstar and Cluster-2 programmes are good results of Starsem's activity. The near future is likely to see the launch of the Mars-Express spacecraft. Also, a contract has been signed to launch the European Metop spacecraft. Negotiations are underway with other potential clients and an issue is being considered to establish a launch-site for Soyuz-2 at the Courou Cosmodrome.

Soyuz LV assembly shop of the Progress plant

TsSKB-Progress is one of Russia's major spacecraft designers, and the leading enterprise where the Earth sensing systems' development is concerned. Among its products are the Zenit, the Yantar, the Resurs-F1, the Resurs-F2, the Kometa and other spacecraft designed to solve the tasks of global ecological monitoring, atmospheric and oceanic studies, climate research, hydrometeorology, industrial activity monitoring, Earth natural resources sensing and weapons limitation monitoring.

Presently, the centre is developing the Resurs-DK high-resolution space system intended for multi-zone remote Earth sensing. The data coming from the Resurs-DK may be used to ensure information support, rational use of nature and industry, monitoring of pollution in atmosphere, water and soil, as well as for timely monitoring of emergency situations and what not. There are plans to launch No 1 Resurs-DK with the Pamela set of scientific equipment in 2004. The Italian Pamela equipment is designed to conduct research on the nuclear and electron-positron composition of the initial cosmic rays.

The centre has made the unique and unrivalled Bion spacecraft to solve certain medical and biological problems. It is used to carry out fundamental and applied research in space medicine and biology, as well as to run radiophysical and radiobiological experiments. Until now 11 such spacecraft have been successfully launched. Among the participants in research are specialists from Germany, the Czech Republic, Slovakia, Canada, Bulgaria, China, the USA, France, the European Space Agency, etc. As of today, a more sophisticated model has been developed under the designation Bion-M.

Foton is a special spacecraft intended for experiments on derivation of various materials, alloys, biological preparations and crystals in microgravity, as well as for fundamental research in zero-gravity physics. The decisive factor for such research, the gravity level, amounts to 10^{-5} – 10^{-6}g at Foton. Among those participating in experiments were specialists from the European Space Agency, France, Germany, Sweden, Canada and other countries, with 12 Fotons launched.

Also, the Foton-M modernised version was developed featuring a two-fold increase in energy consuming for scientific equipment, as well as a better overall technical service aboard the spacecraft.

Optimum technical and economic characteristics of LVs and spacecraft allow TsSKB-Progress to be a successful contender in the international market of space services.

Integration of the Foton-M spacecraft on the Soyuz LV in the assembly and testing facility of Plesetsk range

THE FIRST ALL-WEATHER GENERATION

MIG-21PF FIGHTER AND ITS DERIVATIVES

The first prototypes of the MiG-21 fighter, a milestone aircraft in the annals of international aviation, entered tests slightly over 40 years ago. Introduction of new design solutions and technology innovations in the course of production saw the fighter through decades of distinguished service, and its magnificent potential for modernization helped designers develop a host of modifications. Despite volumes of MiG-21 publications in Russia and abroad, accurate information about the fighter has always been scanty and ambiguous. This article offers the most comprehensive account of a little-reported period in the MiG-21 development history, namely how the MiG-21PF interceptor and its MiG-21PFS and MiG-21PFM derivatives came to existence.

Introduction of air-to-air missiles was a response to increasing flight speeds and corresponding reduction in the time it took the aggressor to leave the engagement zone. The MiG-17PFU and MiG-19PM became the first Mikoyan fighters to carry such missiles: the MiG-17PFU was fitted with the S-1-U missile system comprising the Izumrud-2 RP-1U radar and RS-1U air-to-air missiles, whereas the S-2-U system installed on the MiG-19PM comprised the Izumrud-2 RP-2U radar and RS-2U air-to-air missiles.

These missiles implemented the line-of-sight radar guidance principle, which meant the pilot had to keep the beam of the Izumrud-2 radar locked on the target after missile launch. The situation changed after acquisition of an AIM-9B Sidewinder heat-seeking air-to-air missile, when Soviet designers came up with an analogue. The K-13 launch-and-leave missile (chief designer I.I. Toropov) was developed at the design bureau of Plant No.134 of the GKAT State Committee for Aviation Equipment in 1958.

Even as the K-13 was being tested, Plant No.43 and Plant No.485 launched its production. Dubbed R-3S, the missile entered service after the 16 December 1959-25 March 1960 official tests.

The new heat-seeking missile could be installed on fighters that had no onboard radar. This capability prompted the OKB-155 design bureau to develop the MiG-21F-13 (E-6T) fighter, a derivative of the MiG-21F (E-6) warplane that had just entered production. The new modification was designed to carry K-13 missiles along with the organic NR-30 gun, but missile application proved to be limited by the capabilities of the SRD-5M ranging radar (interfaced with the ASP-5ND sight), which could only define range for visual targets. It was obvious, therefore, that full implementation of the air-to-air missile concept required installing a radar capable of round-the-clock long-range target searching.

This was why the A.I.Mikoyan-led OKB-155 design bureau, at that point engaged in development of the MiG-21F-13 fighter, launched the MiG-21P-13 interceptor project. The 24 July 1958 resolution by the Council of Ministers and the GKAT order (2 August 1958) charged OKB-155 with testing the K-13 missile system, comprising the TsD-30 radar and two K-13 missiles, on two Soviet Air Force MiG-21F fighters

The first E-7 interceptor prototype entered factory tests on 10 August 1959

(the TsD-30 radar was at that point being tested as part of the Mikoyan SM-12-51 and Sukhoi T-3-51 intercept suites); the two demonstrators were deadlined for joint test entry in the fourth quarter of 1959.

Early 1959 saw the design phase completed and technical drawings ready by 68 per cent. The production division was already working on airframe elements and accessories for the first two prototypes for static and flight tests. As Plant No.21 (today the Nizhny Novgorod-based Sokol plant) delayed production of the initial MiG-21F batch, OKB-155 was forced to launch its own production.

The new interceptor (factory codename E-7) differed much from the MiG-21F (E-6) predecessor in terms of design. The nose air intake was slightly elongated and totally redesigned to accommodate the TsD-30T radar; the intake diameter was also enlarged. An enlarged inlet cone housed the radar antenna, its extension operated by a stepless servo control system depending on the flight conditions and engine operation mode.

Guns were not installed in an effort to compensate for increased weight and preserve high performance of the aircraft. The ASP-5N sight was replaced with the primitive PKI-1 collimating sight, which supported employment of bombs, rockets and incendiary tanks and line-of-sight missile application with the radar disabled.

The aircraft carried the KSI directional system, Lazur receiver set of the Vozdukh-1 ground-based guidance system, RSIU-5V V/UHF radio, ARK-54I automatic direction finder, MRP-56P marker beacon receiving unit, RV-U low-range radio altimeter, SRO-2M IFF transponder and SOD-57M ATC/SIF equipment.

The main gear got larger size (800x200B) KT-50/2 wheels for enhanced dirt runway capability and as a compensation for the increased takeoff weight; installation of new wheels resulted in corresponding enlargement of the main gear wheel wells and fuselage wheel pants.

The KKO-3 oxygen system, VKK-4 pressure suit and GSh-4M helmet were introduced for high-altitude operations.

The first E-7 interceptor prototype entered factory tests on 10 August 1959. Test pilot K.K.Kokkinaki and lead engineer V.A.Mikoyan were in charge of the test programme; test pilot I.N.Kravtsov also participated in the tests.

The tests went on successfully until the 28 November 1959 26th flight to reach the maximum M value. A supersonic stall caused the E-7/1 to spin and toss violently, with the pilot subjected to great alternating g-forces. The aircraft then entered an inverted spin, test pilot Kravtsov bailed out successfully. The E-7/1 disintegrated completely on impact with earth. The investigation revealed that the crash had been caused by loss of lateral stability.

The second E-7 prototype was assembled in December 1959; after flutter trials it was delivered to the Flight Research Institute on 18 January 1960.

Lead test pilot P.M.Ostapenko took off for the first flight on 1 February 1960.

The crash of the first prototype moved designers to make certain structural changes to the E-7/2 for increased lateral stability at high M values, such as increasing the fin leading edge area by 0.18m² and the ventral fin area by 0.1m²; installation of BD3-60-21U external racks with reduced lateral face and thickness; and introduction of the KAP-1 single-channel automatic pilot system to ensure roll stabilization.

As distinct from the E-7/1 prototype, the E-7/2 carried the new SK ejection system that supported bailout at the minimum altitude of 110m and maximum airspeed of 1,100km/h. The forward-hinged canopy attached to the ejection seat during egress and shielded the pilot from airflow; 1.5sec after ejection command the AD-3 timer activated the 215F mortars, which unlocked the canopy catch locks, drogue chute boom lock and harness locks; the canopy then disengaged from the seat under centrifugal forces, and the pilot separated from the seat.

During the 72nd flight on 4 July 1960 the engine stalled at maximum speed. Test pilot Kravtsov tried to save the aircraft: he burned nearly all fuel, killed the engine and attempted a landing. Poor aerodynamics prevented the E-7/2 to cover the last 200m to the runway; the aircraft dug into sand and nosed over.

Meanwhile, OKB-155 in December 1959 commenced construction of another two flying prototypes, the E-7/3 and E-7/4, by request from the GKAT chairman. An official order was issued on 15 January 1960.

The E-7/4 entered factory tests on 8 August 1960

The third prototype was accomplished on 4 May 1960. Ensuing factory trials were aimed at determining major technical parameters, inspecting power plant operation and testing the intercept suite in attacks against live and simulated targets.

The E-7/3 had the following improvements over the previous prototypes: the nose wheel steering system dismantled; the wing tank pump dumped in favour of the air pressure fuel pumping principle; the K-13 missile system interfaced with the improved TsD-30T radar to avoid transgression of launch range limitations.

At its 30 May 1960 session the Military Industrial Commission attached to the Council of Ministers decided on launching production of MiG-21PF interceptors at the Gorky-based Plant No.21 in the first quarter of 1961, before completion of the joint tests. The production aircraft was to have the fuel load increased by 380l. Under the 11 June 1960 GKAT order, OKB-155 began retrofitting the fourth prototype, still under construction, for accommodating extra fuel. This time-consuming process involved development, manufacture and installation of new fuel tank, and the E-7/4 flight test programme was therefore postponed. The aircraft got a 170l conformal

The second E-7 prototype carried the new SK ejection system

The third prototype was accomplished on 4 May 1960

The first production MiG-21PF interceptor (No.76210101)

tank behind the canopy and two 150l extra wing tanks.

The first three flying prototypes were powered by the R-11F-300 engine (Article 37F) with 5,740kgf augmented thrust, whereas the E-7/4 had an improved R-11F2-300 engine (Article 37F2) with 6,120kgf augmented thrust. The E-7/4 had a longer fin chord for enhanced lateral stability. The aircraft also got a new KAP-2 single-channel automatic pilot system as part of the aileron control system. The main landing gear was fitted with KT-92 wheels, and the nose gear steering system was replaced with a conventional damper. The airspeed boom was installed above the air intake and oriented along the aircraft axis. The forward fuselage was slightly redesigned to accommodate the TsD-30TP jamproof radar.

The E-7/4 entered factory tests on 8 August 1960; the aircraft then joined the E-7/3 (which had been retrofitted under the E-7/4 project) in official tests, which were successfully accomplished on 30 June 1961. The test programme included 160 E-7/3 flights and 154 E-7/4 flights; the aircraft reached the maximum airspeed of 2,175km/h, service ceiling of 19,000m and range of 1,600-1,700km; the prototypes demonstrated 850m takeoff run and 900m landing roll.

The interceptor was recommended for production and service entry under designation MiG-21PF.

On 28 June 1961, one year after production launch, test pilot S.I.Savchenkov with Plant No.21 flew the first production MiG-21PF interceptor (No.76210101) powered by the R-11F2-300 engine. The aircraft was delivered to the OKB-155 flight test station on 1 July 1961 to confirm the performance results established during the official trials. Test pilot K.K.Kokkinaki performed the first acceptance familiarization flight on 4 July 1961.

After the major parameters were confirmed, MiG-21PF No.76210101 returned to OKB-115 on 13 December to have the TsD-30T radar replaced with the TsD-30TP model under the 26 May resolution.

The new radar had efficient passive jamming and fruit pulse protection, a roll-stabilized antenna and a larger position display. Installation of the new radar required enlargement of the aft-of-cockpit compartment by means of downsizing Fuel Tank 1. The redesigned tank had capacity reduced by 80l.

The modernized aircraft could carry RS-2US (K-5MS) missiles on APU-7 launchers and featured the SRZO-2M Chrom-Nickel IFF system; the air intake duct and wing structure near ribs 2 and 3 were strengthened and the fuselage rearranged to accommodate enlarged air bypass doors; a new nose gear strut was installed, and the main gear guard plates redesigned to provide slots for attaching RS-2US missiles.

Overall, 61 improvements were introduced from December 1961 to January 1962.

The aircraft was again delivered to the flight test station on 12 March 1962; test pilot P.M.Ostapenko on 20 March flew the modernized interceptor for the first time. Factory tests were completed in April same year; on 7 May 1962 Mr. Ostapenko flew the aircraft to the Air Force Scientific and Testing Institute (GK NII VVS) for official tests, which were completed in July. The test commission recommended the TsD-30TP radar for installation on production MiG-21PFs to lower their minimum tactical application altitude from the standard 4km to 2km.

Although the new radar was installed on production interceptors starting from aircraft No.76210703, aircraft No.76210501 and subsequent interceptors already had the aft-of-cockpit compartment enlarged (at the expense of Fuel Tank 1) for subsequent replacement of the TsD-30-30T radar with the TsD-30TP model.

After completion of the radar tests the MiG-21PF was tested with the K-51 system, which comprised the TsD-30TP (RP-21) radar and RS-2US (K-5MS) missiles. Prior to that, on 16 August 1962, the S-13-100, S-13-300 and PAU-471 gun camera pods were installed on aircraft No.76210101 to record missile launch parameters. The official interceptor tests were held from 20 November 1962 to 3 September 1963; the acceptance commission recommended the K-51 weaponry system for installation on the MiG-21PF aircraft to enable adverse weather operation and extend good weather capability. An additional feature of the TsD-30TP radar was the fixed-beam target illumination function that enabled RS-2US missile lock-on and launch against visual targets with use of the PKI-1 sight.

As the MiG-21PF entered production, OKB-155 specialists continued to improve performance of the interceptor and develop new modifications. One line of research here was enhancement of the takeoff and landing parameters.

The No.76210103 production MiG-21PF, delivered to OKB-155 after the No.76210101 machine, got a short takeoff/landing system and the R-11F2S-300 engine (Article 37F2S) with 6,175kgf augmented thrust. The engine featured an air bleeding channel for the boundary layer blowing system, which reduced the landing speed by blowing the boundary layer off of the flaps for increased lift.

The production MiG-21PF interceptor (No.76210725)

The drag chute pod was relocated to the rear of the fin root, above the jet nozzle fairing. This position enabled installation of the 19m² PT-5282-62 drogue chute instead of the standard 16m² PT-6152-59 chute. Also, the drogue chute could now be deployed during flaring, with the wheels still 0.5-1m above the runway, and not after touchdown as was the case with a low-located chute pod.

The reequipped aircraft underwent factory and official tests in the first half of 1962. The boundary layer blowing system combined with a larger drogue chute to reduce the roll to around 480m and landing speed to 240km/h. The take-off run was shortened through installation of two 2,500kgs SPRD-99 boosters. The modernized aircraft entered production under designation MiG-21PFS (E-7SPS, Type 94).

Modernization was continued throughout production. Starting from aircraft No.940912 the interceptor got the KT-102 nose wheel with 500X180A tires and a more efficient braking system. Starting from aircraft No.941001 (after tests on the No.76210725 MiG-21PF), the fin area was expanded to 5.2m² and the fin structure somewhat changed for improved directional stability at high airspeeds.

Starting from aircraft No.941221 the interceptor got the SK-3 (KM-1) ejection seat and a fixed-windshield, right-hanging canopy. The previous system was abandoned after the 8 August 1957 crash of the E-50/3 fighter following the explosion of the S-155 liquid-propellant engine. GK NII VVS test pilot N.A.Korovin bailed out, but incorrect operation of the rescue system killed him. In an effort to avoid such incidents in the future OKB-155 developed the SK-3 (KM-1) ejection seat that could be used for emergency bailout at zero altitude, in the speed envelope from 130km/h during takeoff run and landing roll to 1,200km/h in horizontal flight.

Other innovations were the KKO-5 oxygen system (instead of the KKO-3 system), VKK-6 pressure suit, GSh-6 helmet (or ZSh-3 helmet with KM-32M mask) and VK-3 ventilated suit for high-altitude flights.

The MiG-21PFM (factory code E-7M), a further development from the MiG-21PFS interceptor, had the ASP-PF small-size sight interfaced with the TsD-30TP (RP-21) radar, and also the Samotsvet IR sight.

When used with the ranging radar, the ASP-PF sight enabled daylight precision application of missiles and rockets and any bomb release methods. The Samotsvet infrared sight served for night target detection and application of all weapon types in good weather, irrespective of the flight altitude.

The programme to upgrade the No.76210103 MiG-21PF interceptor was launched after completion of the SPS system official testing programme. The aircraft was fully upgraded by 17 October 1962. Similar to aircraft No.76210101, the interceptor was retrofitted for installation of the TsD-30TP (RP-21) radar and K-51 system. A starboard access door, located symmetrically to the port side access door, was introduced to simplify access to new equipment. Other innovations included the SRZO-2M Chrom-Nickel interrogator-responder, Iskra short-range navigation system and a backward view mirror.

Installation of the new sight forced designers to totally rearrange the cockpit, with the ASP-PF sight positioned in place of the radar display, the Samotsvet infrared sight located next to it and the instrumentation consoles redesigned.

The modernized SPS system was being tested simultaneously with introduction of the new sighting equipment. The E-7M aircraft was submitted for official tests on 27 December 1962. Simultaneously, upon coordination with the Air Force, the aircraft joined the No.76210101 MiG-21PF in official tests of the K-51 system. For this purpose the APU-13 launchers with R-2S were supplanted on the production BD3-60-21U underwing racks by the PU-12-40 launchers with RS-2US missiles. Thus, the E-7M aircraft could carry both R-3S and RS-2US missiles. The interceptor could also carry the APU-7 launcher version developed for RS-2US missiles and S-24 rockets. The ASP-PF sight and RP-21 radar were improved during the official tests.

The E-7M successfully accomplished the official testing programme in 1964 and was recommended for service entry. But new sighting equipment was only introduced starting from aircraft No.94AT01 of Series MiG-21S (E-7S). Starting from aircraft No.94MS01 (Series 20) the interceptor got the RV-UM radio altimeter, ARK-10 automatic direction finder and KM-1 seat with improved position controls. The war-

The MiG-21PFM (factory code E-7M), a further development from the MiG-21PFS

The first prototype of MiG-21PFM had factory code E-7M/1

The MiG-21PF, -PFS and -PFM interceptors were for a long time the mainstay of Soviet Air Force fighter fleet

plane could now carry the GSh-23 twin-barrel gun in the GP-9 pod.

The MiG-21PFM version inherited the E-7SPS Type 94 factory designation from the MiG-21PFS. Furthermore, the MiG-21PFS design had by that time been altered so profoundly the model was also referred to as the MiG-21PFM.

The MiG-21PF and modifications for the national Air Force and air defence were built at the Gorky-based aircraft plant from 1961 to 1968. The same models were built for export at the Moscow-based Znamya Truda plant (today the Voronin Production Centre) from 1964 to 1968.

Configuration of exported MiGs depended on the customer country. MiG-21PF and MiG-21PFM Variant A fighters exported to countries of people's democracies had no S-24 rockets and incendiary tanks, and had the Zarya add-on system removed from the SRZO-2 suite.

The MiG-21PFMs exported to Vietnam under designation MiG-21PFL had the same weapons and equipment configuration as the Variant A warplanes, except that they had the ARK-10 direction finder without distance flown counter, a more advanced KSI-2 directional system and no radio altimeter.

Aircraft exported to capitalist countries (MiG-21FL, Type 77, Variant B) were stripped of more weapons and equipment. They did not carry RS-2US missiles, had the RSIU-5G radio, SRO-1 IFF responder, ARK-10 direction finder without distance flown counter, KSI-2 directional system, RV-UM radio altimeter, and R-1L or R-2L radars, export versions of the RP-21 and RP-21M radars respectively.

The Nasik-based aircraft plant of Indian company HAL launched licensed MiG-21FL production in 1966.

The MiG-21PF, -PFS and -PFM interceptors were for a long time the mainstay of Soviet Air Force and air defence fighter units, and were exported to many countries, which operated them until the early 1990s.

Development of advanced MiG-21S, MiG-21SM and MiG-21bis fighters resulted in gradual retirement of MiG-21PF, -PFS and PFM warplanes, which were then used as highly manoeuvrable drone targets instead of nearly-extinct MiG-15, MiG-17 and MiG-19 targets.

The new drones, designated M-21 and M-21M (the last "M" standing for "manoeuvring"), were outwardly identical to baseline warplanes and became the most popular remote-controlled targets. The drone project was developed jointly by the OKB KAI design bureau of Kazan Aviation Institute and the Gromov Flight Research Institute; the Lvov-based aircraft repair plant stripped retired warplanes of radars, aims, radios, oxygen system and other equipment and installed drone equipment. The ejection seats were not dismantled, since every drone was test-flown by a pilot prior to operation.

The standard drone equipment set included the automatic control system with AP-17 automatic pilot system (in the nose) and servo units, flare dispenser, miss distance/hit detection equipment, external tracking system, daylight tracer and other equipment.

The M-21M had a takeoff weight of 8,400kg and could operate from dirt and concrete runways. The preflight inspection time equalled 40min; the drone had the altitude envelope from 50m to 14,400m, 180km/h maximum airspeed at 10-11km, 106min endurance and 8.5g maximum manoeuvre load factor.

Development of more powerful and efficient engines, introduction of advanced avionics, expansion of the weapons range and enhancement of weaponry performance eventuated in development of the ubiquitous MiG-21PF warplane into several modifications featuring sufficiently higher performance and capable of efficiently counteracting contemporary enemy assault assets.

Yevgeny ARSENYEV,
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The M-21M drone could operate from dirt and concrete runways

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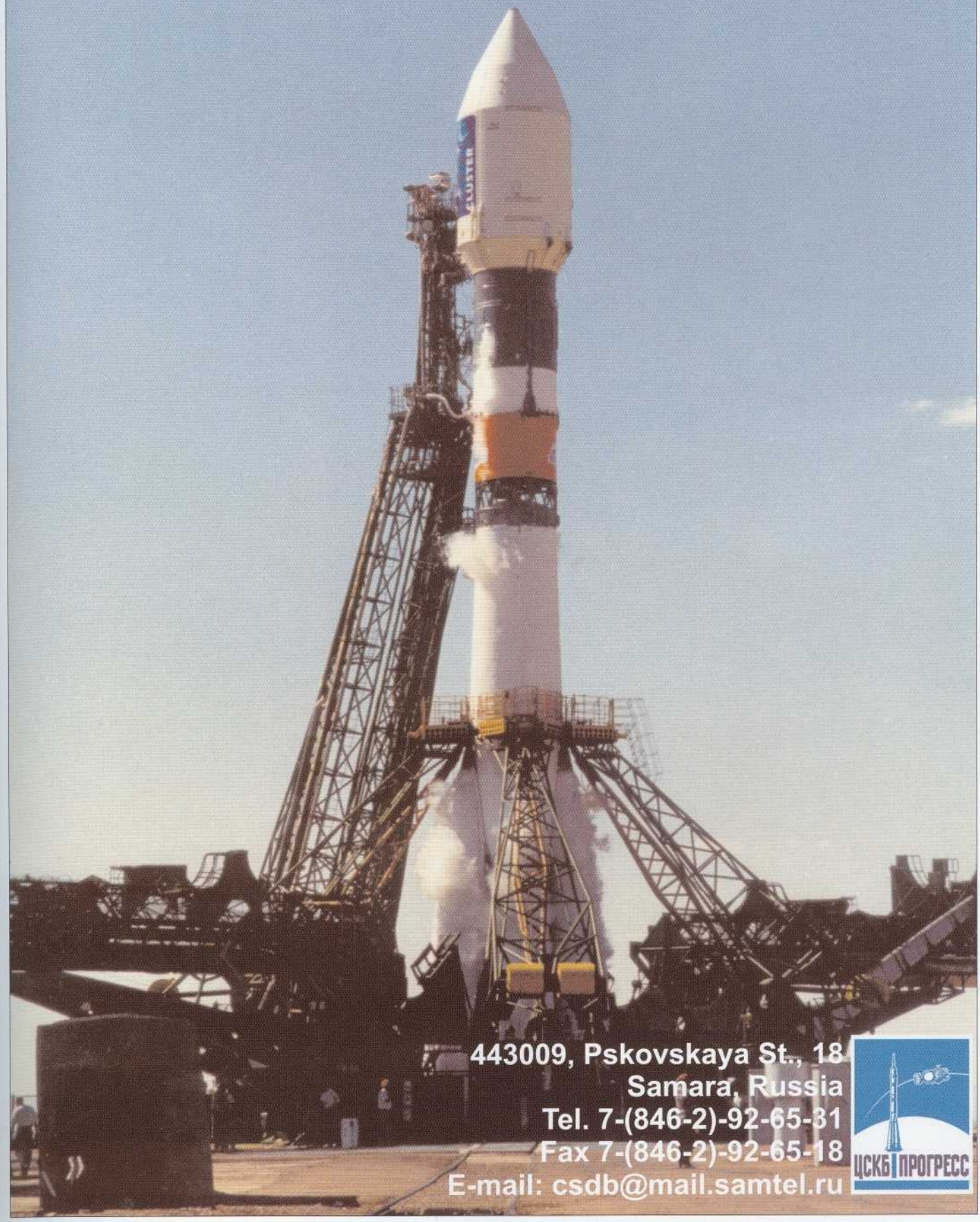

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